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EG&G Idaho, Inc./Westinghouse Idaho Nuclear Company
Idaho Falls, Idaho

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Report on Surface Geophysical Surveys at the Idaho Chemical Processing Plant

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REPORT

to

Westinghouse Idaho Nuclear Company

on

Surface Geophysical Surveys at

The Idaho Chemical Processing Plant,

Idaho Falls, Idaho

Prepared by Golder Associates Inc.

Redmond, WA

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Authorization and Objectives

This report has been prepared by Golder Associates Inc. (GAI) under contact number C86-131159 with EG&G Idaho, Inc. at the Idaho National Engineering Laboratory (INEL). Golder is a sampling subcontractor for drilling and sampling activities at the Idaho Chemical Processing Plant (ICPP).

This report presents a technical description and interpretation of surface geophysical surveys carried out as part of Phase VI drilling and sampling activities at the Idaho Chemical Processing Plant (ICPP). The purpose of the sampling and analysis program is to investigate potential chemical releases at five land disposal units (LDU) and two solid waste management units (SWMU).

Surface geophysical surveys were specified for SWMU CPP-14, SWMU CPP-36, LDU CPP-37, and LDU CPP-63 in technical work plans prepared by GAI[1,2] for characterization of these units. Surface geophysical surveys were chosen to provide rapid, non-invasive, and cost-effective reconnaissance of shallow subsurface conditions of these sites prior to detailed drilling and sampling. The survey techniques used were selected to direct subsequent drilling operations.

The specific objectives of the geophysical surveys were to determine the capabilities of the instruments within the boundaries of the ICPP to locate and identify shallow underground utilities and other possible anomalous areas.

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[1]Golder Associates Inc., 1990. Technical Work Plan for the Idaho Chemical Processing Plant Sampling and Analysis Program at Solid Waste Management Unit CPP-14.

[2]Golder Associates Inc., 1990. Draft Technical Work Plan for the Idaho Chemical Processing Plant Sampling and Analysis program at Land Disposal Units CPP-37, CPP-40, CPP-47, CPP-48, CPP-63 and Solid Waste Management Unit CPP-36.

2. SITE BACKGROUND

Geophysical surveys were carried out at the sites shown on Figure 1. The following sections provide a brief background of each site.

2.1 SWMU CPP-36

This site consists of two underground waste transfer lines which are thought to have leaked an undetermined amount of liquid wastes. Contamination was encountered at depths of 6 to 8 feet and was postulated to extend along the entire length of these lines.

2.2 LDU CPP-37

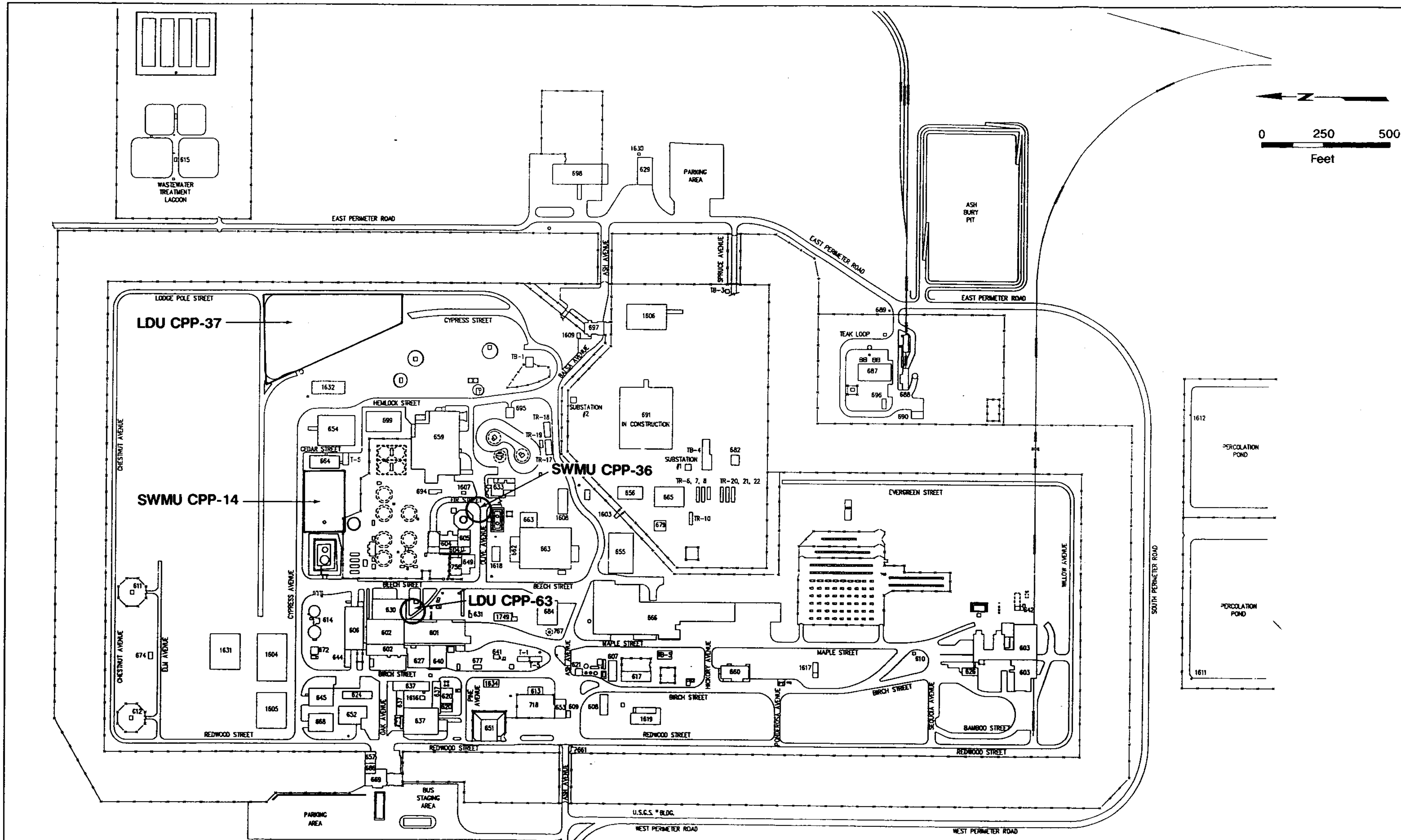
This site consists of two abandoned gravel pits, one located outside the security fence (Pit #1) and one located inside the security fence (Pit #2). Only Pit #2 was investigated as part of the geophysical surveys. Materials disposed into Pit #2 include sanitary waste, construction debris, and miscellaneous chemical wastes. The construction debris included several large concrete hatch covers. Pit #2 was backfilled flush with the surrounding grade and no surface features are present which indicate the former boundaries of the pit.

2.3 LDU CPP-63

This site consists of a 500 gallon underground tank (VES-YDA-106) and a one-inch transfer line (LE-1013A) used for storage and transfer of hexone (methyl isobutyl ketone). A leak occurred in the transfer pipe in 1982 when a backhoe damaged the transfer pipe. Information regarding the size of the release or any clean-up efforts was not documented.

2.4 SWMU CPP-14

This is the site of a decommissioned sewage treatment plant built in the early 1950's that operated until 1982. The plant consisted of an Imhoff digestion tank, a trickling filter, a chlorine contact basin, sludge drying beds and a drainfield. Demolition of the facility reportedly included: (1) removal of facilities and associated equipment to a depth of five feet below grade; (2) removal and disposal of all sludge; (3) removal of all buried piping with the exception of the 12-inch influent line and 6-inch effluent line to the drainfield. The exact location of the facility with respect to present surface features and coordinates is not well known.



ICPP-A-16678
(6-90)

FIGURE 1
SITE PLAN
EG&G/ICPP GEOPHYSICS

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3. GEOPHYSICAL INSTRUMENTATION AND SURVEY TECHNIQUE

3.1 Ground Penetrating Radar (GPR)

A ground penetrating radar (GPR) instrument introduces electromagnetic energy at a radar frequency (100 to 500 MHz) from a transmitter antennae and measures radar pulse reflections at a receiver antennae. Both antennae are enclosed in a mobile sled which is pulled along the ground surface producing a chart recording of radar reflections along a survey line. The timing and character of the reflected radar pulses can be interpreted in terms of depth and character of a subsurface interface. Radar pulses are reflected at distinct changes in electrical conductivity of the subsurface. These interfaces can be caused by layering in the soils or by discrete objects such as pipes or other debris. Layering in soils can often be identified directly on the GPR record, whereas discrete objects, or targets, produce an anomalous reflection such as a parabola or chaotic reflections. By performing repeated survey lines in a grid fashion, the distribution and extent of these interfaces can by mapped and interpreted. GPR is commonly used to locate underground pipes, utilities, and other metallic objects which have high electrical conductivity contrast with surrounding soils. Interpretation of radar profiles is dependent on the depth, orientation and type of the targets, and the electrical characteristics and distribution of soils.

The GPR instrumentation was provided by WINCO and consisted of a GSSI SIR System 8 radar amplifier with remote chart recorder and both a 300 MHz and 500 MHz antennae. In addition, Golder provided a 120 MHz antennae and a GSSI SIR system 3 radar amplifier. Comparison of the radar antennae indicated that the 300 MHz antennae produced the best radar profiles, but also produced a band of noise at about 40 nano seconds (ns). Radar penetration with the 120 MHz and 500 Mhz antennae was generally not greater then 40 ns, so the 300 MHz antennae was used on all of the surveys. The cause of the noise band on the 300 MHz antenna was not determined, but may be related to the cable separation between the transmitter and receiver electronics on the antenna housing. Maximum GPR penetration depth at the sites investigated is estimated at about 10 feet based on an average radar velocity of approximately 0.25 ns/ft. This velocity is consistent with typical valves for dry sand and agrees with a "slant range" calculated value obtained over a known pipe target. All GPR surveying was carried out according to a technical procedure[3] for GPR surveying.

3.2 Electromagnetic Induction (EM)

Electromagnetic induction (EM) surveys are carried out by introducing a 1 to 10 KHz frequency EM field into the subsurface via a transmitter coil and measuring a resultant secondary EM field at receiver coil separated some distance from the transmitter. The intensity of the secondary field is related to the electrical conductivity of the subsurface, which is a useful indicator of changing soil conditions or the presence of conductive objects, such as pipes, in the subsurface. The depth of penetration using the EM technique

[3]GAI, 1990. Technical Procedure TP-1.1-4, Ground Penetrating Radar Surveying.

is depended on soil conditions, transmitter/receiver separation, and coil orientation. The two EM instruments used in this survey were an EM-31 and EM-34. Maximum penetration depths for these two instruments are summarized on Table 1.

TABLE 1

MAXIMUM PENETRATION DEPTHS FOR EM INSTRUMENTS[4]

Instrument	Coil Separation	Maximum Penetration Depth	
		Horizontal Dipole	Vertical Dipole
EM-31	3 m	3 m	6 m
EM-34	10 m	7.5 m	15 m
EM-34	20 m	15 m	30 m
EM-34	40 m	30 m	60 m

The EM-31 is a fixed coil instrument with a constant coil separation of 3m. The maximum penetration depth of the instrument is about 18 feet, depending on ground conductivity. The EM-31 measures both the quadrature and in-phase components of the secondary EM field generated by the transmitter. The quadrature component is the normal operating measurement and detects ground conductivity based on the magnitude of the secondary field. The in-phase component is a measure of the phase lag between the primary and secondary fields and is particularly sensitive to metallic objects.

The transmitter/receiver separation for the EM-34 can be varied up to 40m, which provides a range of penetration depths. Only the quadrature component of the EM field is measured with the EM-34.

EM surveys are generally carried out over a grid, so that the resulting measurements can be contoured to produce a map of apparent ground conductivity. EM instruments are sensitive to cultural features, such as overhead power lines, fences and buildings. The EM surveys 6were carried out according to technical procedures[5,6] for EM-31 and EM-34 surveys.

[4]Geonics, 1985. Technical Note TN-6. Electromagnetic Terrain Conductivity Measurements at Low Induction Numbers.

[5]GAI 1990. Technical Procedure TP-1.1-5, Electromagnetic Surveying (EM-31).

[6]GAI 1990. Technical Procedure TP-1.1-6, Electromagnetic Surveying (EM-34).

4. SITE GEOPHYSICAL SURVEY RESULTS

4.1 SWMU CPP-36

4.1.1 Survey Objectives and Grid

The objective of the survey was to locate a waste transfer line (PUA-3002) between the ICPP Main Stack and the Waste Calcining Facility (WCF) and possibly identify the extent of contamination away from the transfer line (Figure 2). The area between the Main Stack and the WCF contains a number of underground and overhead utilities, pipes, and cathodic protection. Waste transfer line PUA-3002 is a 1 1/2-inch line located with a 24-inch concrete encased pipe (CON-101297) and directly adjacent to a 10-inch concrete encased pipe (PUA-3001). According to the underground utility maps, both ends of PUA-3001 and PUA-3002 are capped, but the locations of the caps are approximate. The EM-31 was used to try and identify possible contamination away from the waste transfer line, and the GPR was used to determine the location and depth of the underground pipes.

A survey baseline was established between the western edge of a confined space entry manhole located immediately south of the main stack, and the northwest corner of building CPP-633. Survey lines were run perpendicular to the baseline at 10 foot intervals. Figure 2 shows the survey grid established at SWMU CPP-36, and utilities shown on the utility map.

4.1.2 GPR Results

The GPR survey detected several targets corresponding to pipes shown on the utility map. Figure 2 shows the location of the pipes as determined by tracing the path of the GPR targets identified on successive survey lines. The 24-inch line (CON-101297/PUA-3002) shows up clearly on lines 50, 60 and 70, while the 10-inch line (PUA-3001) is distinctly detected only on line 70. It is probable that PUA-3001 also extends to line 50. The GPR survey indicates that the waste transfer lines do not extend farther west than line 40, indicating that only about 30 feet of pipe remains in the ground, as compared to 50 feet indicated on the utility map. The depth of the pipe is estimated at between 6 and 7 feet. In addition to the abandoned waste transfer lines two other pipes shown on the utility map (PSA 100475 and CON 101298) were detected. These lines could not be tracked beneath the main utility corridor, which overwhelmed the radar response. A fourth linear feature was also detected that is not shown on the utility maps (Figure 2). This feature could be a pipe or an electrical utility.

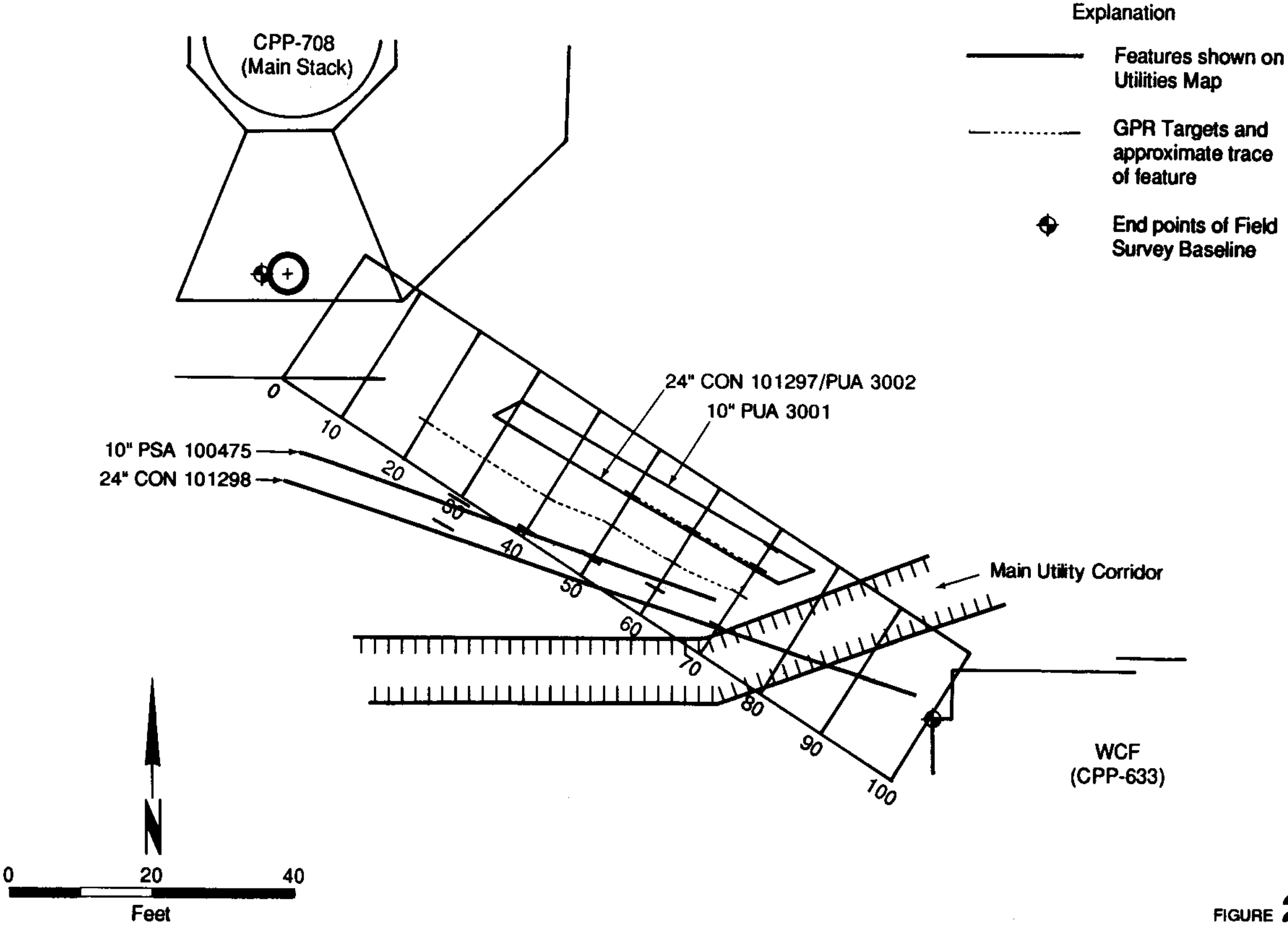

FIGURE 2

GEOPHYSICAL SURVEY GRID AND GPR TARGETS: SWMU CPP-36

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4.1.3 EM-31 Results

The EM-31 survey was unable to determine the possible extent of contamination away from the waste transfer line. This is due primarily to unacceptable noise levels created by the overhead and underground utilities in the area. The results of the EM survey are not presented in this report.

4.2 LDU CPP-37

4.2.1 Survey Objectives and Grid

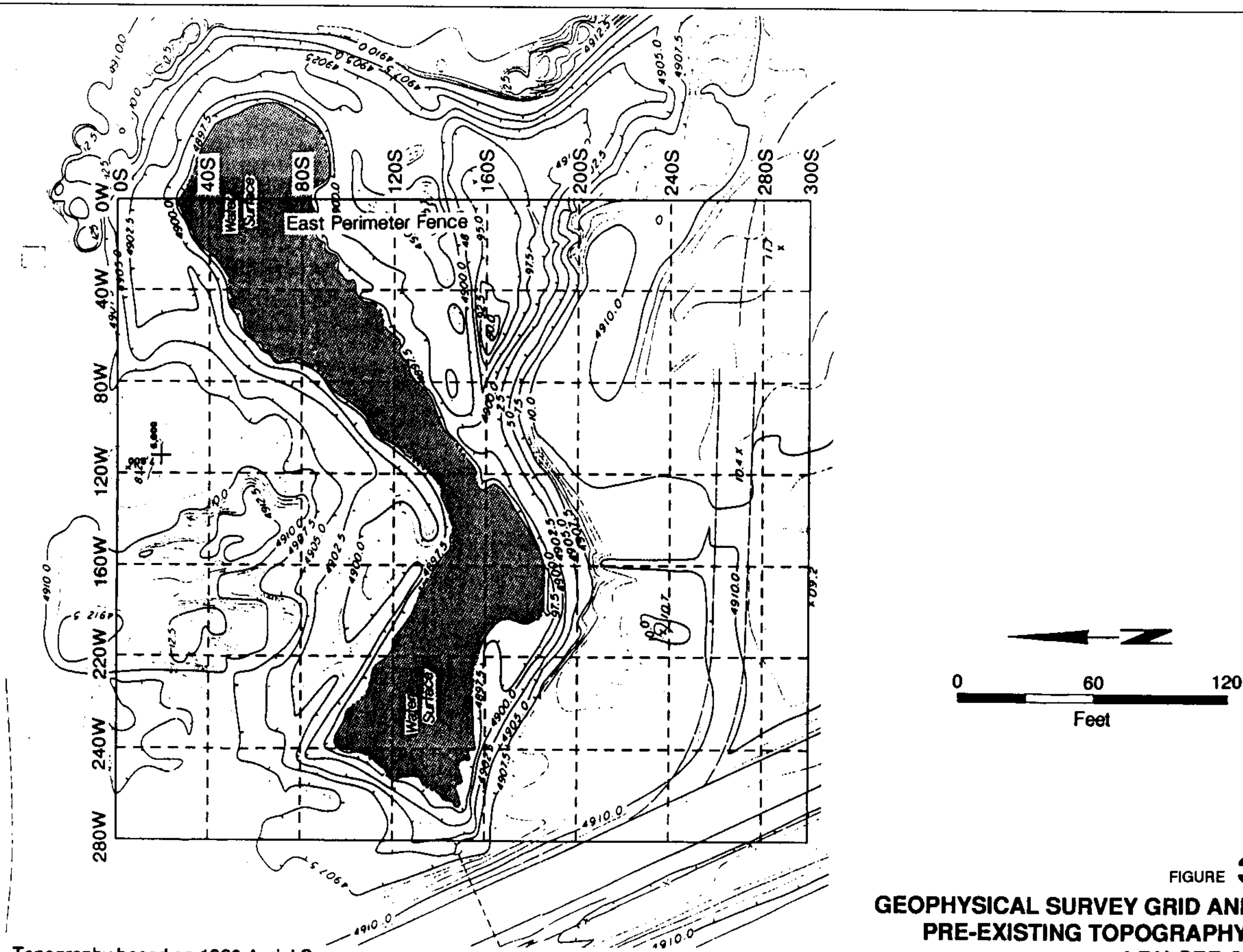
The objectives of the geophysical surveys conducted at LDU CPP-37 were:

- Determine the lateral extent of the former gravel pit;
- Identify the deeper portions of the pit;
- Locate possible debris that could be obstacles to drilling;
- Identify possible contamination in the soils;

To accomplish these objectives, several geophysical surveys were conducted over a grid established on the site. A survey grid was established over the area using the East Perimeter Fence as the eastern edge (Line 0W). The grid is shown on Figure 3. A subsequent tie-in with WINCO survey coordinates and the 1980 aerial topographic survey map indicated that the abandoned gravel pit extended approximately 80 feet east of the East Perimeter Fence. This area was not included in the geophysical survey grid.

4.2.2 EM-31 Results

The EM-31 survey was conducted at a 10-foot station interval with 20-foot line spacing. At each station, measurements were taken with the EM-31 boom oriented both north-south and east-west. Each measurement of ground conductivity consisted of the in-phase and quadrature components of the induced EM field. Apparent ground conductivities ranged from less than 2 mmhos/m to over 15 mmhos/m, which is consistent with previous estimates of conductivity. Conductivity was similar in both the N-S and E-W orientations, indicating that there are no major anisotropic features within the survey area. Both ground conductivity and in-phase component were contoured using the commercial contouring package SURFER. The resulting contour maps are presented in Appendix A, Figures A-1 through A-4. These contour plots are also presented in Appendix C as transparent overlays which can be used to evaluate the EM results with respect to pre-existing topography.



Topography based on 1980 Aerial Survey

FIGURE 3

GEOPHYSICAL SURVEY GRID AND PRE-EXISTING TOPOGRAPHY: LDU CPP-37

EG&G GEOPHYSICS

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The contoured results of the EM-31 were evaluated by overlaying the EM contour plot onto the 1980 topographic map of the pit. The conductivity map appears to generally correspond to the boundaries of the abandoned gravel pit. Conductivities between 2 and 4 mmhos/m correspond to undisturbed soils, and conductivities greater than 6 mmhos/m indicate fill materials. Conductivities greater than 10 mmhos/m were interpreted as anomalous, indicating areas of different fill/soil conditions or the presence of conductive targets. Within the boundary of the gravel pit, there are two discrete targets that appear on both the conductivity and in-phase maps. These discrete targets appear as "bulls-eyes" on the contour plot and are probably caused by metallic objects. However, the exact nature of the object cannot be determined with the EM instrument. In addition to the two discrete targets, four additional areas of anomalous EM response were identified and are summarized below:

- A E-W trending lobe of increased ground conductivity and in-phase response between 150S and 200S, (the southeastern portion of the grid). This lobe appears to correspond to a previous topographic depression shown on the aerial survey map. This depression extends about 5 feet below the elevation of the water surface shown on the aerial topography.

- An area of increased ground conductivity and in-phase response around (100W,50S). This area does not appear to correspond to a topographic feature.

- An area of increased ground conductivity and in-phase response around (220W,40S). This area also corresponds to a pre-existing depression in the gravel pit.

- An area of increased in-phase response around (240W,120S). A distinct conductivity anomaly was not apparent here, but the area corresponds to the former edge of the water surface in the western portion of the pond.

4.2.3 EM-34 Results

The EM-34 survey was conducted at 10m, 20m and 40m coil separations in both horizontal and vertical coil orientations. Station spacing was 40 feet for the 10m and 20m coil separations, and 80 feet for the 40m coil separation. The resulting contour plots for each coil spacing and each coil orientation are presented in Appendix A, Figures A-5 through A-10. Similar to the EM-31 conductivity maps, the EM-34 maps describe ground conductivities to deeper depths within the gravel pit area.

A summary of the EM responses at various coil spacings and orientations is shown on Table 2, and was developed from evaluating the overlays of the computer contour plots over the 1980 aerial topographic map.

TABLE 2

SUMMARY OF EM-34 RESPONSES AT LDU CPP-37

Coil Spacing and Orientation	Description
10m Horizontal Dipole	>Eastern high conductivity lobe widens; >Northeastern edge of pit well defined; >Decreased conductivity around (50S,200W).
10m Vertical Dipole	>Eastern high conductivity lobe not well defined; >Southwest trend of original water surface apparent.
20m Horizontal Dipole	>High conductivity anomaly at (40W,120S); >Area of increased conductivity in northwest portion of grid.
20m Vertical Dipole	>Significant increase in conductivity along eastern edge of grid.
40m Horizontal Dipole	>Areas of increased conductivity in northwest and southeast portion of grid.
40m Vertical Dipole	>Very strong increase in conductivity along eastern edge of grid.

4.2.4 GPR Results

The GPR survey was conducted along north-south traverses of the grid at a 20-foot line interval. A map of GPR targets and features of the record was produced by visually inspecting each traverse and annotating a grid at the same scale as the EM plots. Figure 4 shows the distribution of features detected with the GPR instrument. Penetration depths for the instrument were generally less than 10 feet, which is within the theoretical limitations of the instrument in these soil conductivity conditions. Selected GPR profiles are presented in Appendix B, Figures B-1 through B-4. The results of the GPR survey are summarized as follows:

- A number of randomly distributed small discrete targets were identified. This would be typical of fill containing miscellaneous debris.

- A large, probably metallic, target was detected at (250W,60S), which corresponds to a conductive anomaly detected with the EM-31.

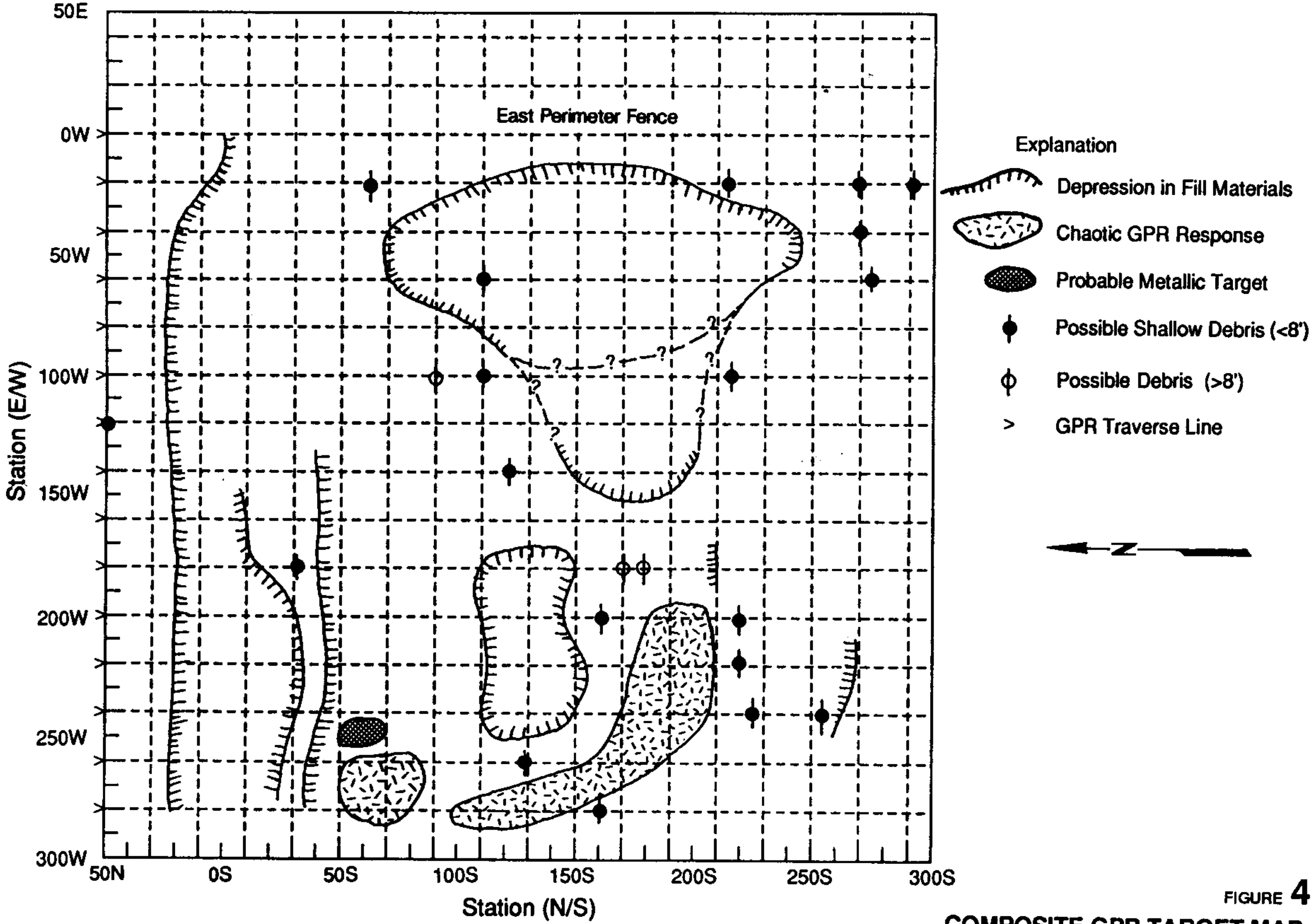

FIGURE 4

COMPOSITE GPR TARGET MAP: LDU CPP-37

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PROJECT NO 893-1195.950 DWG NO 23588 DATE 1/10/91 DRAWN TK

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- The edge of the fill appears on the GPR records as a dipping interface. This interface becomes attenuated below about 30 ns.

- A shallow depression in the fill materials is present along lines 40W through 80W (See Figure 4). This corresponds to the pre-existing depression shown on the 1980 aerial topographic map and the conductive lobe detected with the EM-31. The strength of the reflection suggest a relatively conductive interface.

- A chaotic GPR response was observed in the southwestern portion of the grid. No anomalous response was measured in this area with either the EM or magnetometer.

4.2.4 Interpretation

The following interpretations of the EM conductivity maps and GPR profiles are proposed based on the correlations between geophysical surveys and overlays of EM and GPR anomalies onto the aerial topographic map of the gravel pit produced in 1980:

- There is a metallic object located near grid coordinate (250W, 60S) which was detected with both the EM and GPR instruments. This could be a small buried tank or some other type of metallic debris.

- There is a E-W trending shallow depression in the fill between 120S and 200S detected with both the EM and GPR instruments which probably contains conductive soils. These soils could be native fill with increased clay content, or potentially contaminated. The depression is probably deepest at the eastern edge of the anomaly, based on a shortening of the lobe detected with the EM-34 at the 10m coil spacing.

- The southwest area of the grid, where the chaotic GPR response (see Figure 4) was observed, is the most likely area containing the abandoned hatch covers dumped into the pit. This is interpreted by the lack of anomalous EM measurements in this area, which suggests an area of predominantly non-metallic debris. Although the hatch covers are constructed with reinforced concrete and stainless steel, the volume of metal, compared to the volume of concrete and surrounding soil may not be sufficient to produce a significant EM anomaly. The GPR, on the other hand, produces a distinct reflection at the interface of the hatch cover and soil.

- The deepest portion of the gravel pit is most likely near coordinate (40W,80S), based on the response of the EM-34 at the 20m vertical dipole measurements. This area roughly corresponds to the eastern portion of the water covered area of the former gravel pit.

- Numerous other small, discrete GPR targets were identified with the geophysical survey, but are not likely to be obstacles to drilling. However, the GPR survey did not achieve maximum penetration depth and was carried out on a relatively coarse grid using north-south traverses only. Undetected obstacles may exist.

- The distinct increase in conductivity at the eastern edge of the grid shown on the 20m-vertical and 40m-vertical EM-34 measurements is difficult to interpret. The presence of the fence and other underground utilities in this area suggests that cultural noise may be the cause of the response. However, the conductivity increase is only apparent on the vertical-dipole measurements. Both the 20m-horizontal and, the 40m-horizontal measurements made adjacent to the fence do not show large increases in conductivity. In addition, an EM sounding conducted off-site, near deep well 123, showed a similar response, with oscillating conductive readings at the 20m-vertical and 40m-vertical spacings and stable resistive readings in the horizontal orientation. Further tests would be necessary to fully interpret this behavior, but there is the possibility that the response is related to an anomalous EM response at the basalt/alluvium interface.

4.3 LDU CPP-63

4.3.1 Survey Objectives and Grid

The objectives of the geophysical survey at CPP-63 were to verify the location of an abandoned underground pipe leading from an underground hexone tank. The pipe was known to have broken and leaked an unknown amount of contaminant. A survey grid was established at the site as shown on Figure 5, with a survey lines running perpendicular to the axis of the pipe at 5-foot intervals.

4.3.2 GPR Results and Interpretation

The GPR survey detected the pipe on all 10 traverses at a depth of between 4 and 5 feet. Figure 5 show the trace of the targets corresponding to the pipe. In addition, the GPR records indicate a change in the reflective character of the soils between lines 25 and 30 (see Appendix B, Figure B-9). In this area, the soils around the pipe become nearly transparent on the GPR record, indicating attenuation of the radar signal. The location of this change in soil conditions corresponds to the location where the pipe is thought to have broken and leaked contaminant. Radar signals can be attenuated in the presence of organic contaminants because of a lowering of the dielectric constant. This attenuation and transparent radar record has been demonstrated at several sites where free organic product (gasoline or diesel fuel) was present on the water table. It is possible that the change in reflective character of the soils at CPP-63 may be due to the presence of high levels of organic contamination around the broken/leaking pipe. It is also possible that the attenuation is due to changes in soil type and/or disturbance of the soil caused by previous excavation in the area. Drilling will be necessary to evaluate the soil conditions in this area.

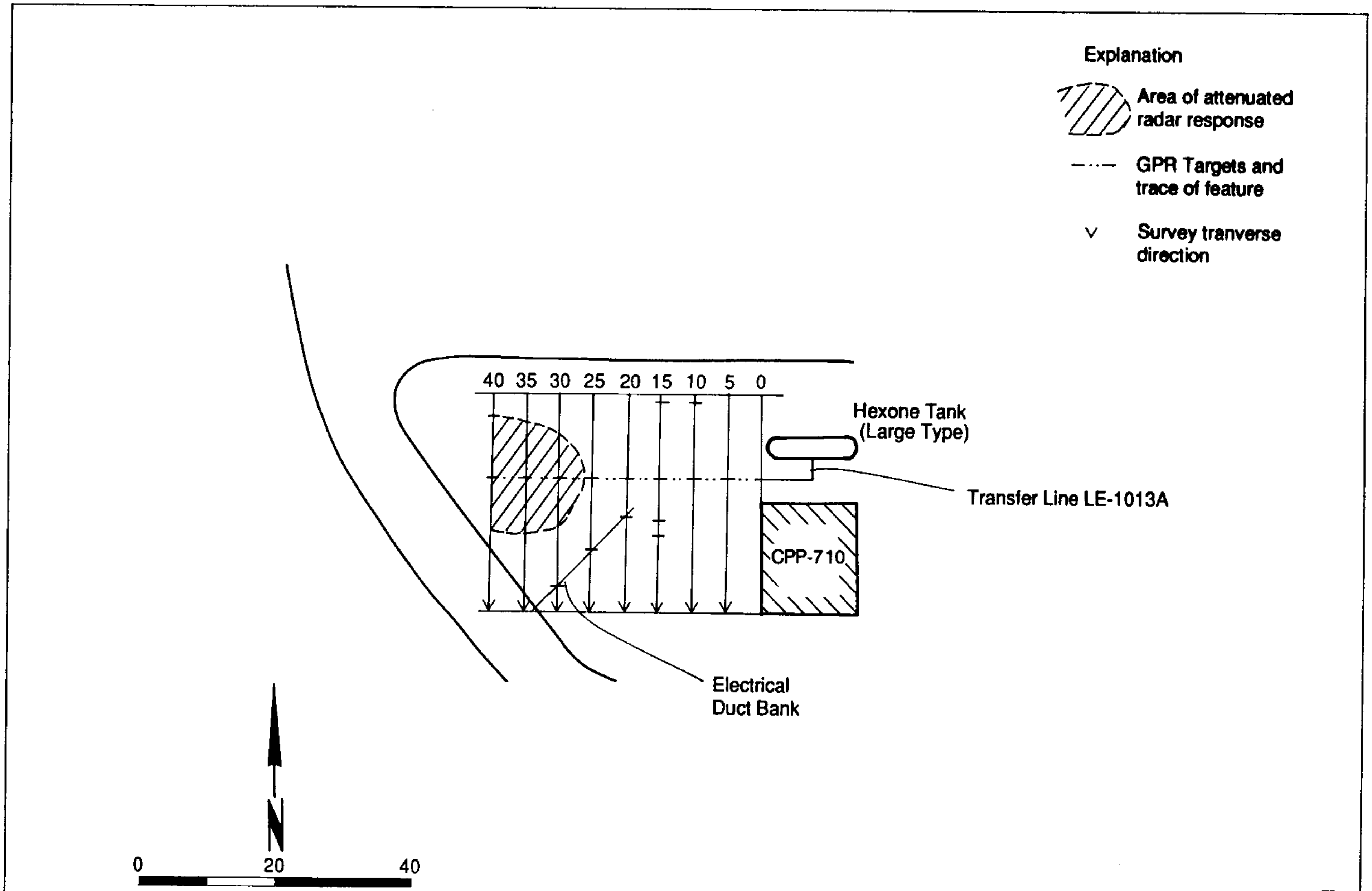

FIGURE 5
GEOPHYSICAL SURVEY GRID AND GPR TARGETS: LDU CPP-63
EG&G/ICPP GEOPHYSICS

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4.4 SWMU CPP-14

4.4.1 Survey Objectives and Grid

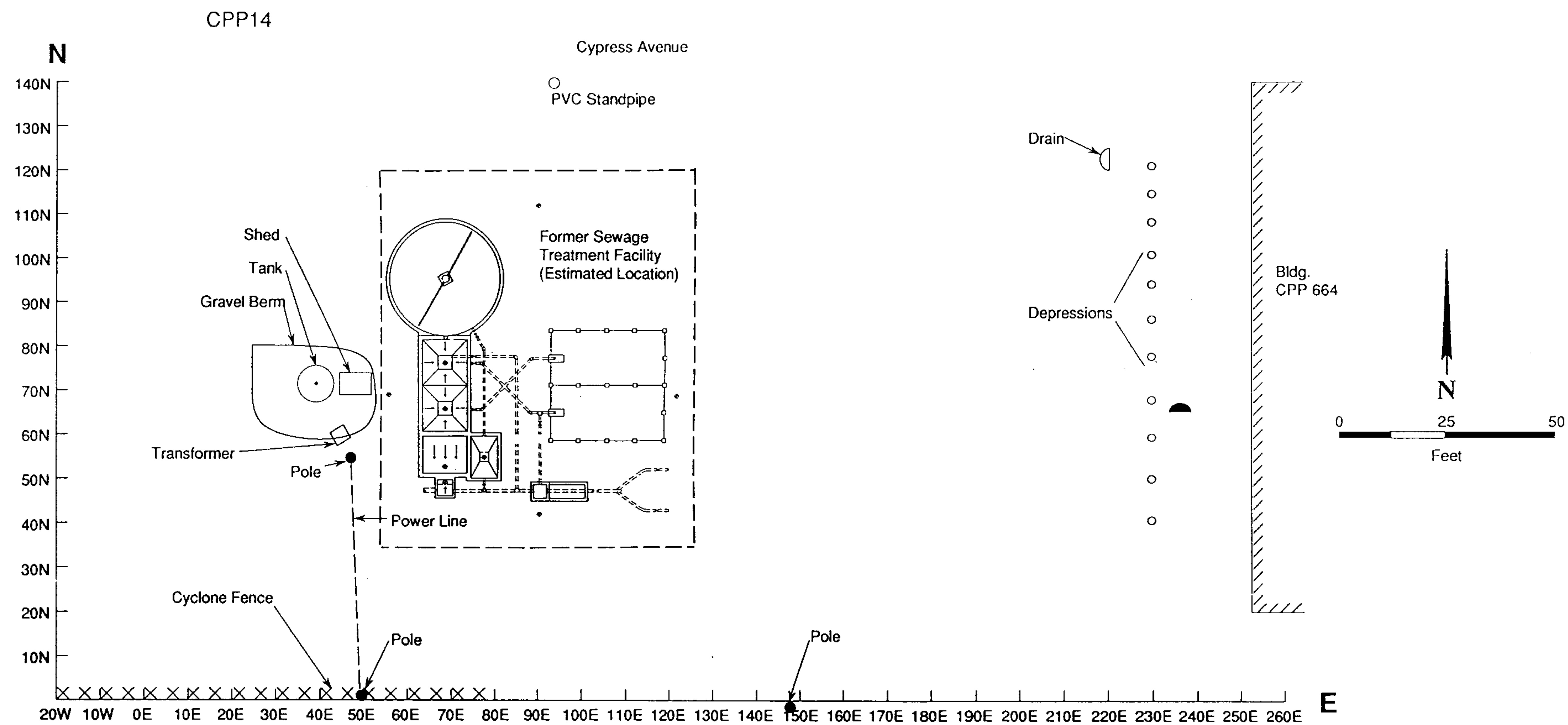
The site characterization plan for CPP-14 calls for drilling and sampling within certain pre-existing structures related to the abandoned sewage treatment facility buried beneath the site. The exact location of the facility, relative to existing buildings and coordinates was not certain based on existing maps and surveys. The objective of the geophysical survey was to identify all or part of the pre-existing facility so that existing as-builts of the facility could be used to accurately locate borings within certain structures.

A survey grid was established over the site as shown on Figure 6. The GPR instrument was traversed across the grid in both the east-west and north-south directions to identify pipes aligned in either direction.

4.4.2 GPR Results and Interpretation

The GPR instrument produced good profiles with numerous shallow targets. The targets were transferred to the map on Figure 7, noting the traverse direction of the instrument. Many of the targets cannot be definitively correlated from one traverse to the next, and are therefore assumed to be discrete objects within the fill. These targets are simply left as dots on the map. Many of the targets, however, can be traced from one profile to the next, indicating an underground pipe or utility. These targets are connected with lines. The most extensive feature is a pipe extending along line 50N, from coordinate 60W to beneath building CPP-644. This was initially thought to be the drainfield line. This pipe produces a strong reflection at a depth of about 6 feet, and the strength of this reflection suggests that the pipe is metallic, and/or large diameter. However, the drainfield line is specified as 6 inch clay or concrete, trending in a southwest direction. There are several targets trending in a southwest direction that could possibly be interpreted as an underground pipe; which would correspond to the drainfield pipe as shown on the as-built diagrams. These targets are difficult to discern on the record, but this would be consistent with a small diameter concrete pipe. It is possible that the stronger reflector is an older metallic pipe leading towards the abandoned gravel pit (LDU CPP-37).

For either interpretation of the location of drainfield pipe, the strong reflectors at 50N on lines 60 through 110E probably correspond to the cast iron/concrete pipes between the influent manhole and the chlorine contact basin. This provides a north-south fix on the location of the treatment facility. A map of the abandoned facility was prepared at the same scale as the target map and overlayed to try and match the GPR targets to the facility structures. A transparent overlay of the facility is provided in Appendix C and can be used to superimpose the facility structures onto the GPR targets on Figure 7. A match line of the likely configuration is shown on both the overlay and Figure 7. The position of the facility in the north-south direction is assumed to be fixed by the apparent influent and drainfield



Location of waste water treatment plant based on best estimate from geophysical survey

FIGURE 6
GEOPHYSICAL SURVEY GRID: SWMU CPP-14
EG&G/ICPP GEOPHYSICS

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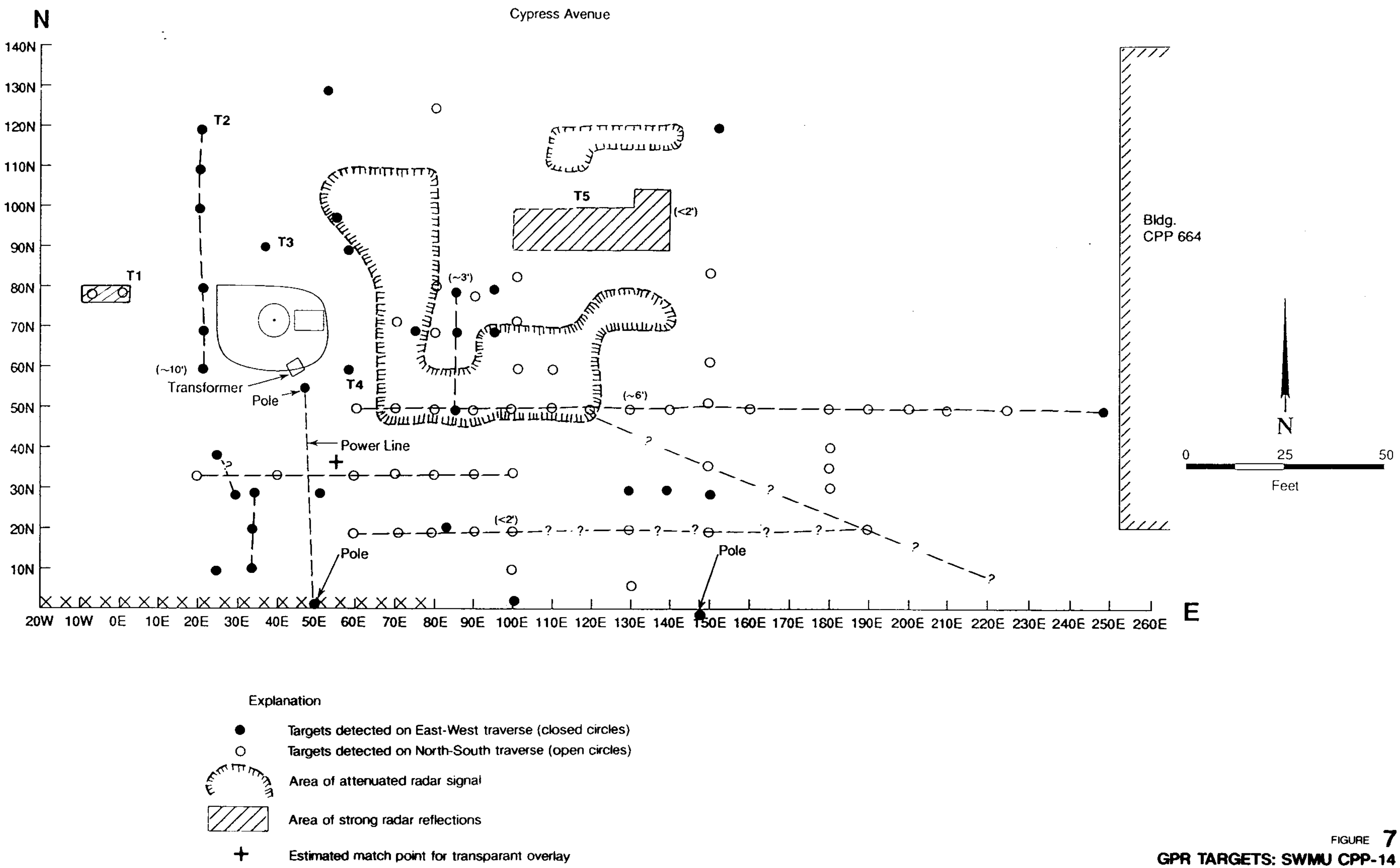

FIGURE 7
GPR TARGETS: SWMU CPP-14
EG&G/ICPP GEOPHYSICS

PROJECT NO 893-1195.950 DWG NO 23595 DATE 1/11/91 DRAWN TK

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pipes. It is difficult to match the facility overlay to the GPR targets by moving in a north-south direction. A number of targets are located north of the presumed drainfield line around (80E, 70N). The as-built diagrams for the facility indicate a network of cast iron pipes between the Imhoff tank and the sludge drying beds which may have been left in place when the facility was demolished. The facility overlay matches this network of pipes to a number of the GPR targets in this area. With the facility in this configuration, areas that appear transparent on the GPR record, correspond to the abandoned trickling filter and tank areas, as well as part of the sludge drying beds. The transparent response of the GPR in these area may be attributed to the placement of a fairly uniform fill after excavation of these areas.

The position of the facility described above appears to best fit the GPR data, but there are other possible configurations that also match many of the GPR targets. For example, shifting the overlay 10 feet east also seems to produce a viable match with many of the GPR targets. A definitive map of the former facility cannot be inferred from the GPR survey, although there are similarities between the distribution of targets and the structure of the facility. Further investigation of demolition plans, interviews with personnel, and additional detailed GPR surveys may be desirable prior to initiating drilling.

In addition to the structures that appear to correspond to the abandoned facility, several additional deep targets were detected during the survey. These are shown as targets T1 through T6 on Figure 7.

- Target T1 is a strong reflector approximately 20 feet long oriented east-west at a depth of approximately 6 feet. This target may be an underground tank.
- Target T2 is a strong reflector approximately 60 feet long, oriented north-south at a depth of approximately 10 feet. This may be an abandoned pipe.
- Target T3 is a moderately strong discrete reflector of unknown orientation at a depth of about 8 feet. The nature of this reflector is difficult to determine.
- Target T4 is a very strong reflector at a depth of 6 feet. This target may be a small tank or a large metallic object.
- Target T5 is a strong flat reflector covering a rectangular area. This may be a pre-existing reinforced concrete or grating structure.

5. CONCLUSIONS AND RECOMMENDATIONS

The results of the surveys conducted within the ICPP indicate that shallow surface geophysics is a viable reconnaissance technique for evaluation of underground obstacles and preliminary characterization of shallow sub-surface conditions within the ICPP facility. All interpretations presented in this report are based on correlation of available information and the results of the surveys conducted. Available information included as-built diagrams of old facilities, existing utility maps, and previous topographic surveys. Drilling and/or excavation will be necessary to verify the interpretations of features suggested in this report, and additional features may exist that were not identified from these surveys. The geophysical data collected appears to be of good quality and applicable to the ongoing drilling and sampling program at the ICPP, but surface geophysical surveys should not replace detailed drilling and sampling at any of the sites being characterized.

The following section provide recommendations for further investigation and/or recommended drilling locations based on the geophysical surveys.

5.1 SWMU CPP-36

We recommend that the GPR instrument be utilized just prior to initiating drilling at this site to finalize the location of the borings. Specifically, the exact trace of the various pipes and utilities should be marked on the ground surface prior to locating the borings. The location of the borings indicated in the work plan appear sufficient for characterization of the site.

5.2 LDU CPP-37

We recommend siting of the borings at the following locations (see Figure 8) of the geophysical survey grid.

(160W, 40S): Depression in fill and anomalous soil conductivity;

(40W, 80S): Deep portion of gravel pit;

(220W, 140S): Anomalous soil conductivity, depression in fill;

(40W, 160S): Anomalous soil conductivity, near chaotic debris zone.

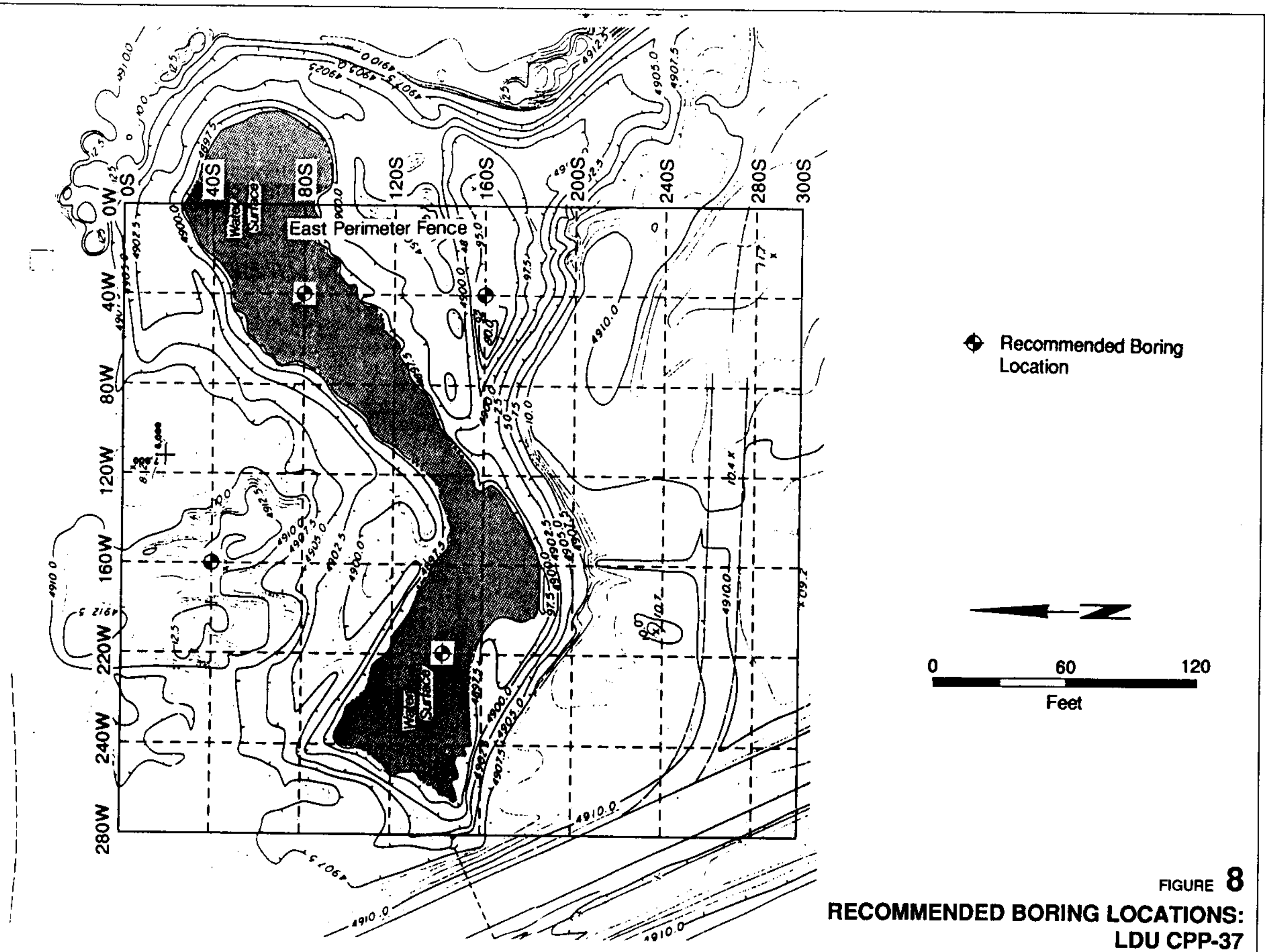


FIGURE 8

RECOMMENDED BORING LOCATIONS: LDU CPP-37

EG&G GEOPHYSICS

PROJECT NO. 893-1195.950 DWG. NO. 23590 DATE 1/10/91 DRAWN TK

Golder Associates

5.3 LDU CPP-63

The proposed boring location at this site corresponds to the first GPR profile that exhibited attenuation of the radar signal. This response may be attributed to increased contamination in the soils associated with the break in the transfer pipe. Attenuation of the signal was more pronounced on profiles west of the proposed boring location. We therefore recommend that a boring be located 5 to 10 feet west of the proposed location to intersect the zone of significant attenuation. If high levels of contamination are detected, we recommend further surveying with the GPR to delineate the contaminated area.

5.4 SWMU CPP-14

We recommend the following coordinates (from the field geophysical grid) for drilling and sampling as specified in the characterization plan:

Imhoff Tanks :	(68E, 78N), (69E, 68N)
Ejector Pit :	(68E, 55N)
Chlorine Contact Basin:	(90E, 58N)
Sludge Drying Beds:	(120E, 70N)

These coordinates were selected based on the best estimate of the facility location determined from the distribution of GPR targets. Additional information may help to provide a more accurate location of the facility. Prior to initiating drilling, each boring location should be profiled to verify the absence of shallow obstacles to drilling.

In addition to the boring locations specified in the work plan, there are three additional features that may require investigation. These features have been labeled as T1, T2, and T4 and have characteristics similar to tanks or pipelines. These features should be investigated if drilling at the locations specified in the work plan indicates significant levels of contamination.

The location of the drainfield cannot be reliably determined from the distribution of GPR targets within the geophysical survey grid. There is a distinct pipe or utility extending from the estimated location of the facility to beneath building CPP-664. The strength of the GPR reflections from this feature are not consistent with a small diameter concrete pipe, and it is therefore unlikely that this is the drainfield line. A much less distinct feature trending southwest is apparent on some of the GPR profiles, and may correspond to the drainfield line. Additional profiles are recommended to further characterize this feature.

APPENDIX A

ELECTROMAGNETIC DATA AND CONTOUR PLOTS

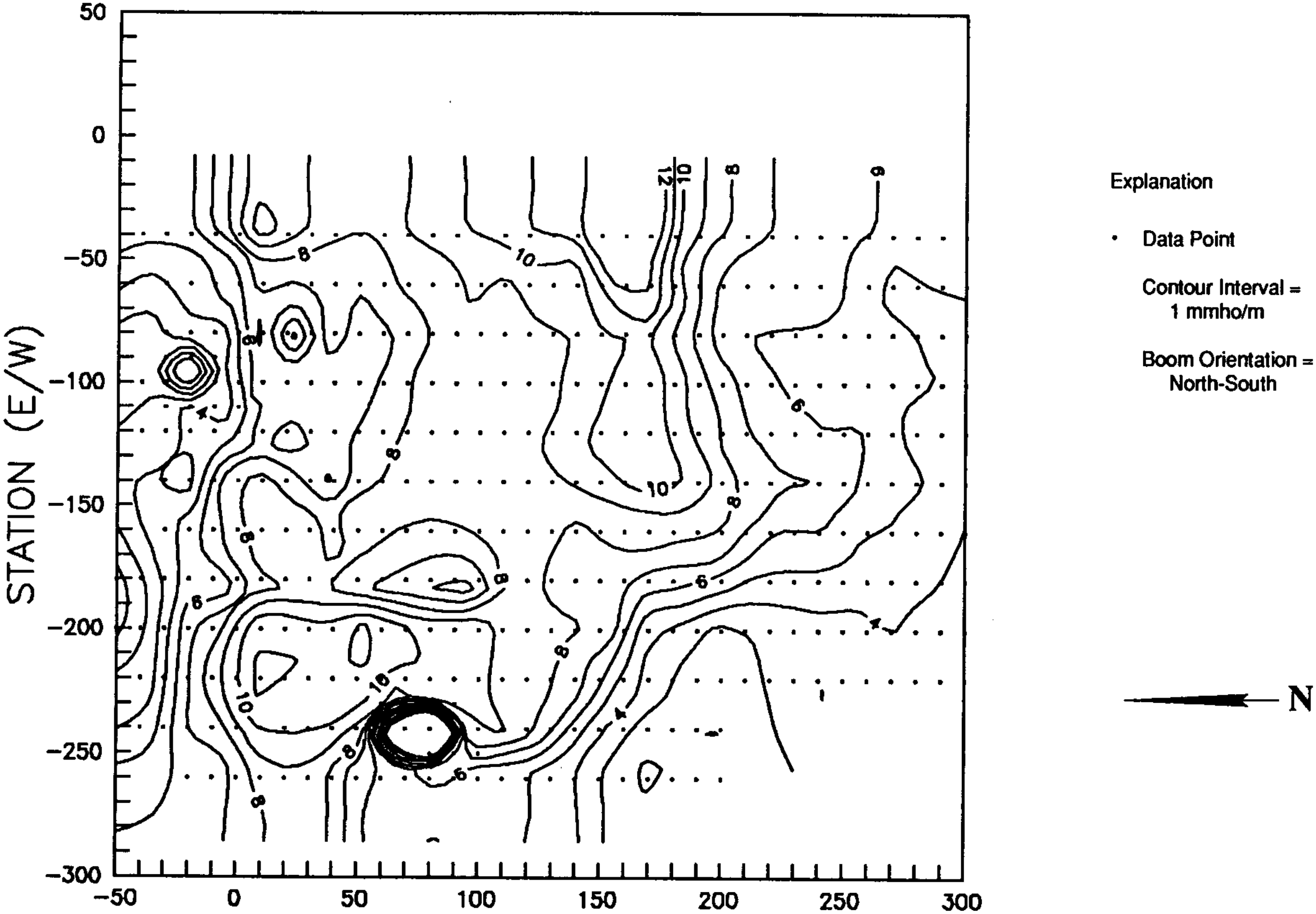


FIGURE **A-1**

GROUND CONDUCTIVITY MAP-
EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

Golder Associates

PROJECT NO. 893-1195.950 DWG. NO. 23496 DATE 1/8/91 DRAWN HP

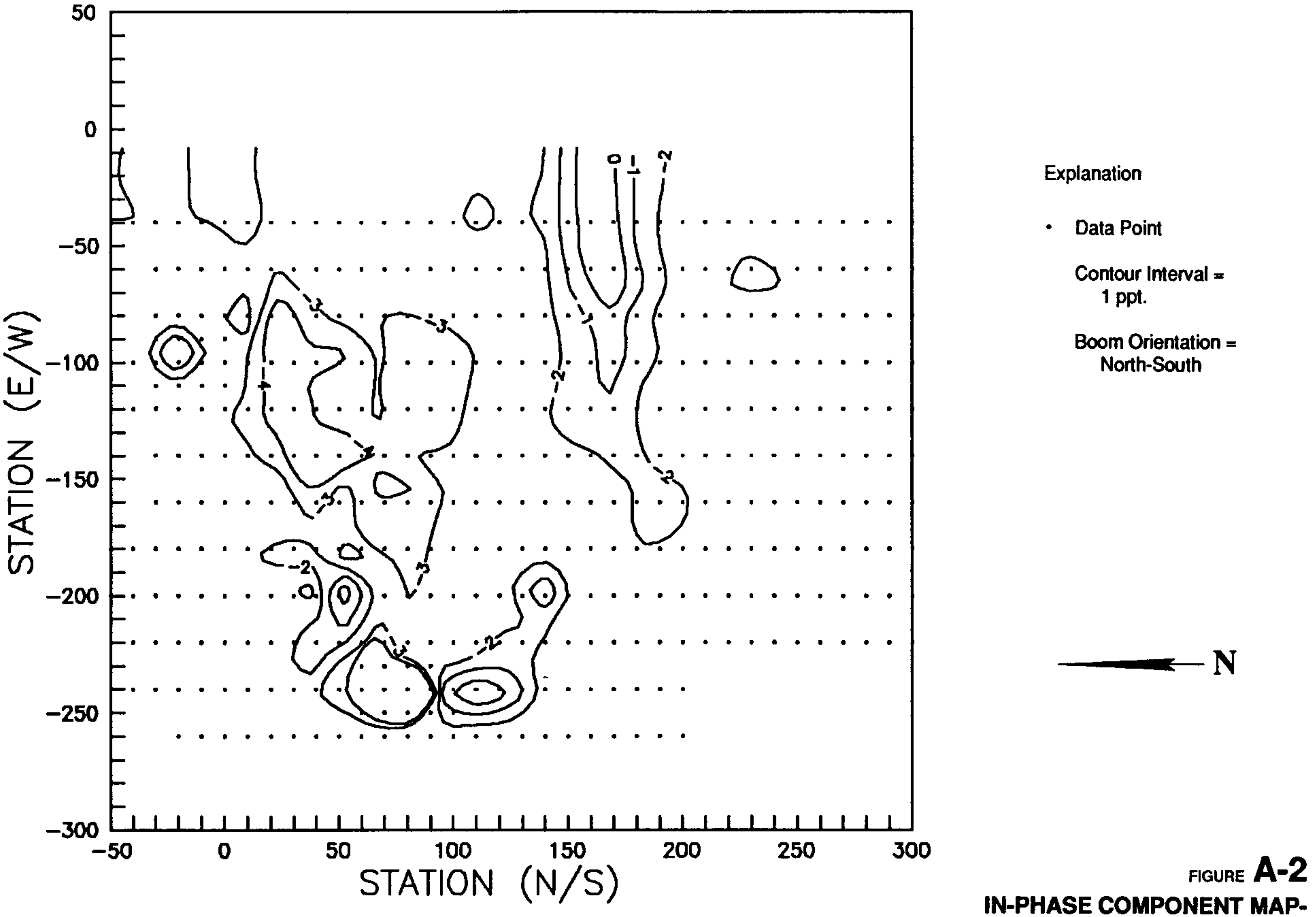


FIGURE **A-2**

IN-PHASE COMPONENT MAP-
EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23497 DATE 1/8/91 DRAWN HP

Golder Associates

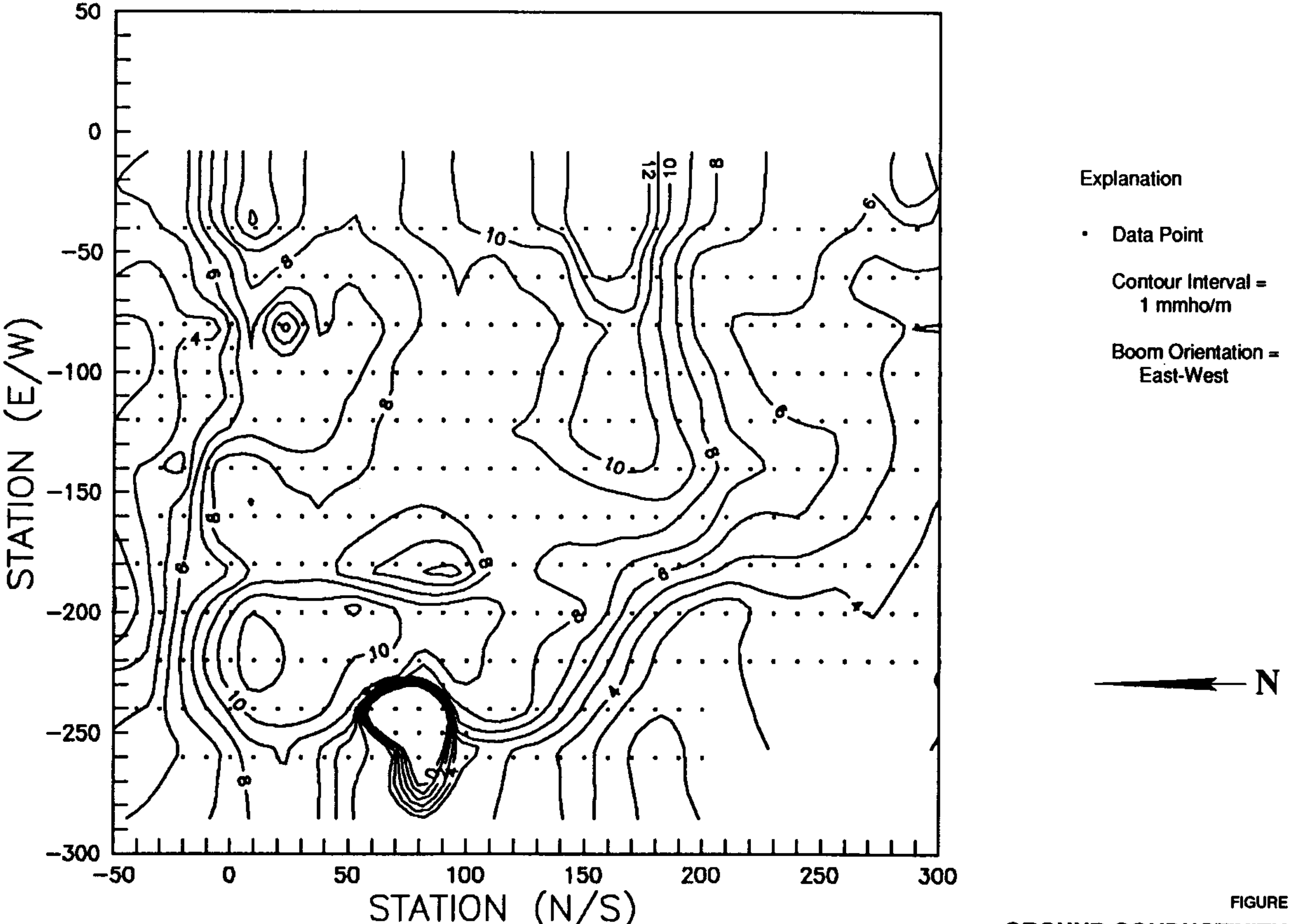


FIGURE **A-3**

GROUND CONDUCTIVITY MAP-
EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23498 DATE 1/8/91 DRAWN HP

Golder Associates

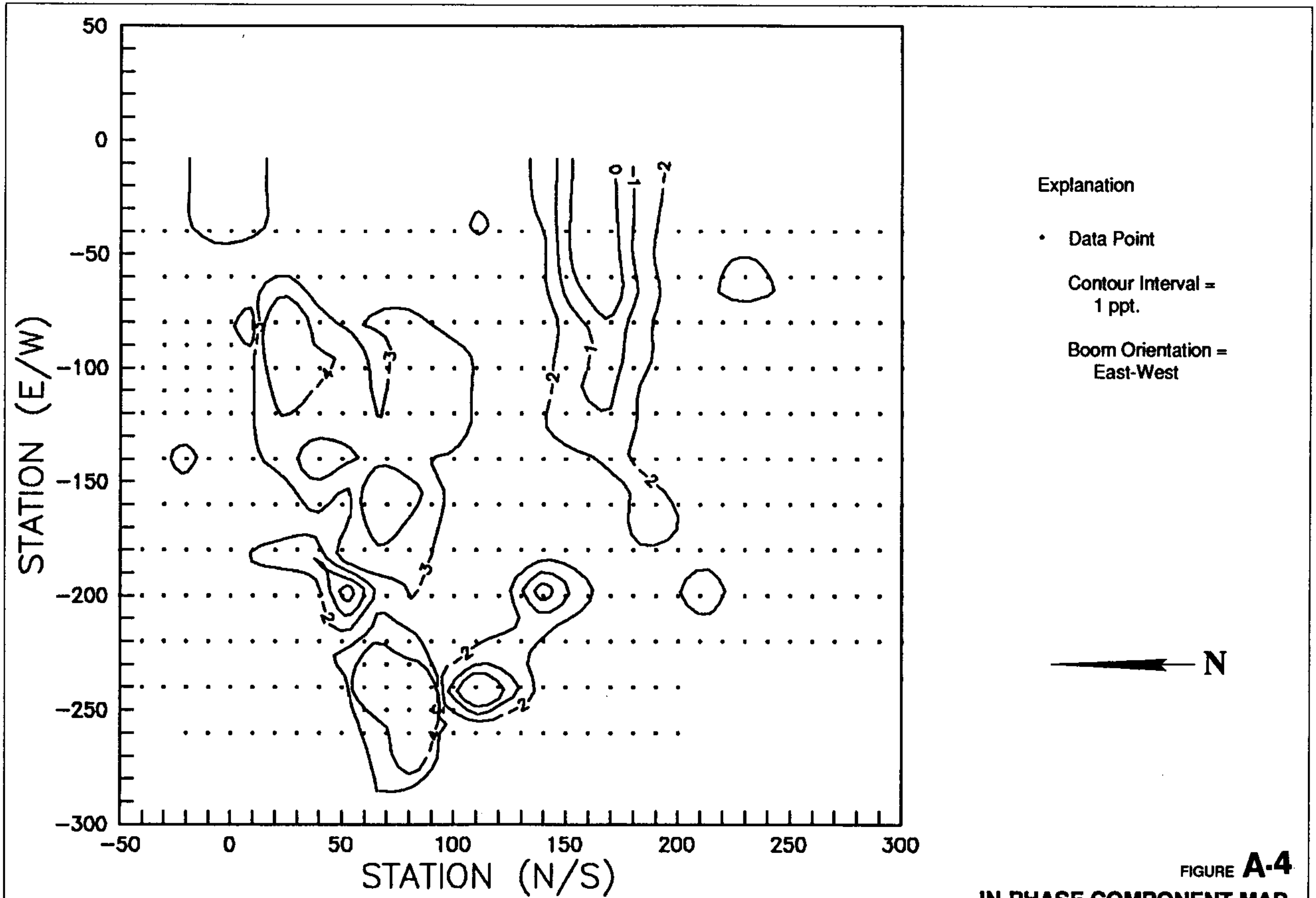


FIGURE **A-4**

IN-PHASE COMPONENT MAP-
EM-31 AT LDU CPP-37
EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23499 DATE 1/8/91 DRAWN HP

Golder Associates

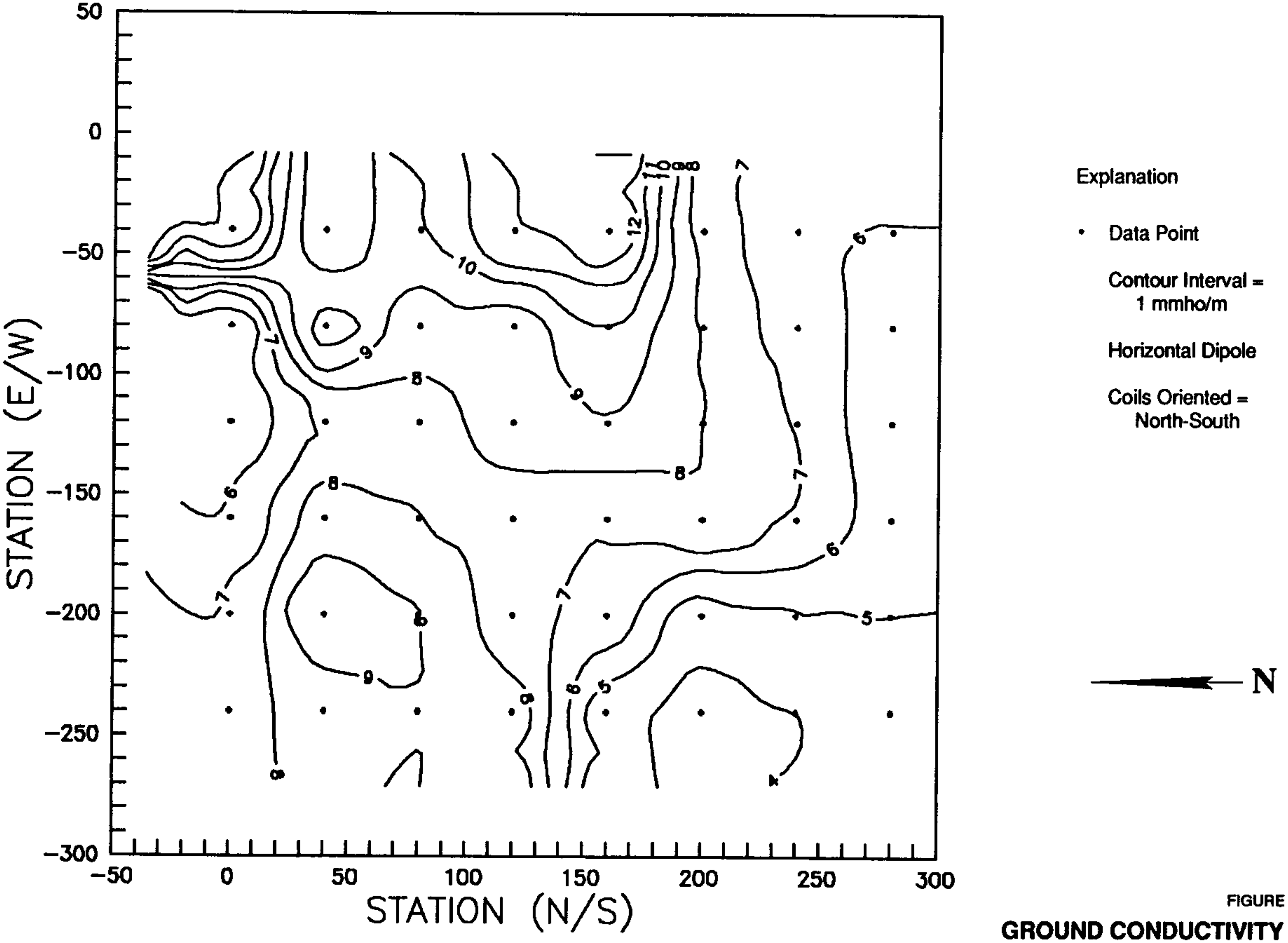


FIGURE **A-5**

GROUND CONDUCTIVITY MAP-
EM-34/10M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23500 DATE 1/8/91 DRAWN HP

Golder Associates

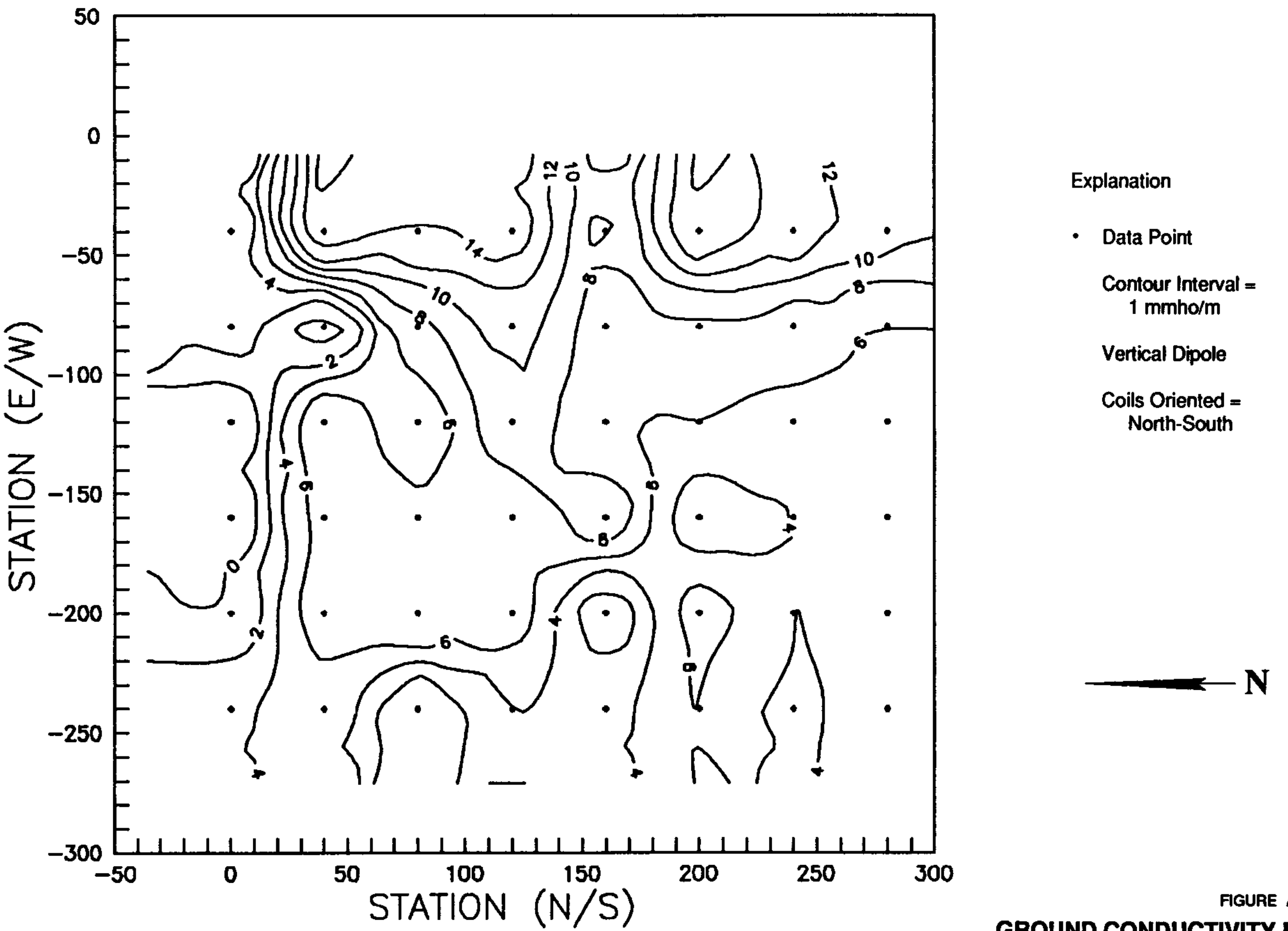


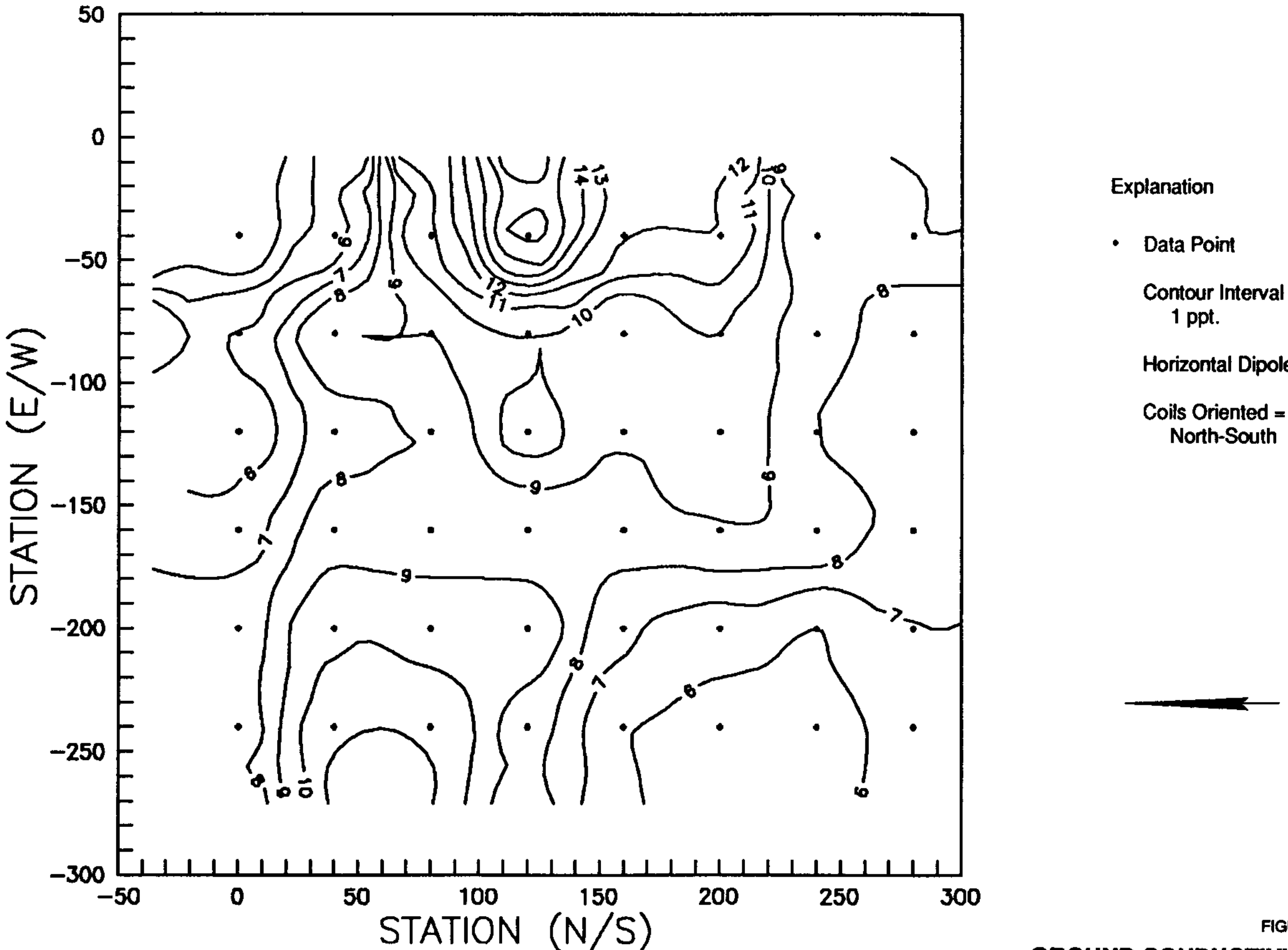
FIGURE **A-6**

GROUND CONDUCTIVITY MAP-
EM-34/10M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23501 DATE 1/8/91 DRAWN HP

Golder Associates



Explanation

• Data Point

Contour Interval = 1 ppt.

Horizontal Dipole

Coils Oriented = North-South

FIGURE **A-7**

GROUND CONDUCTIVITY MAP-EM-34/20M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23502 DATE 1/8/91 DRAWN HP

Golder Associates

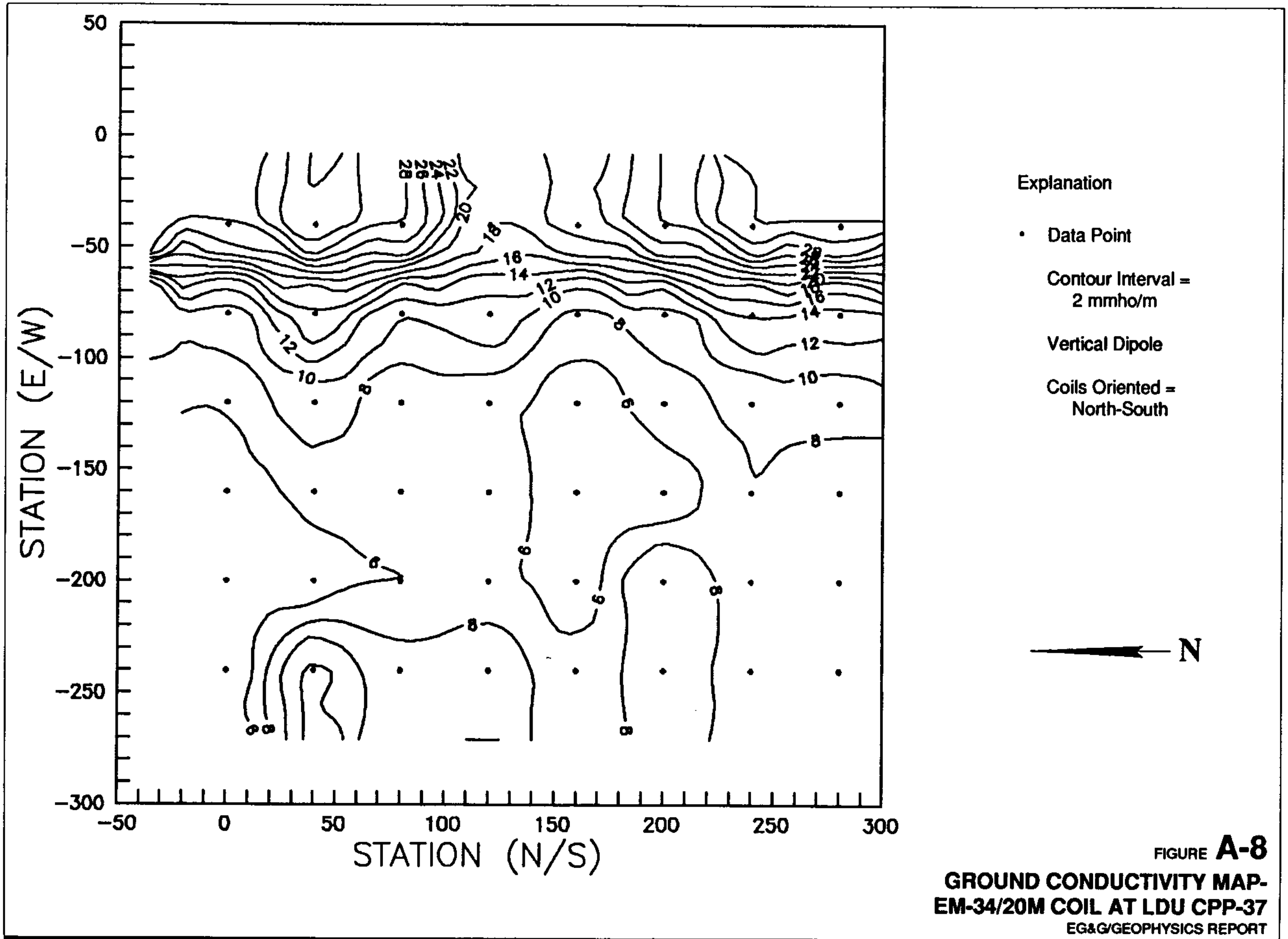


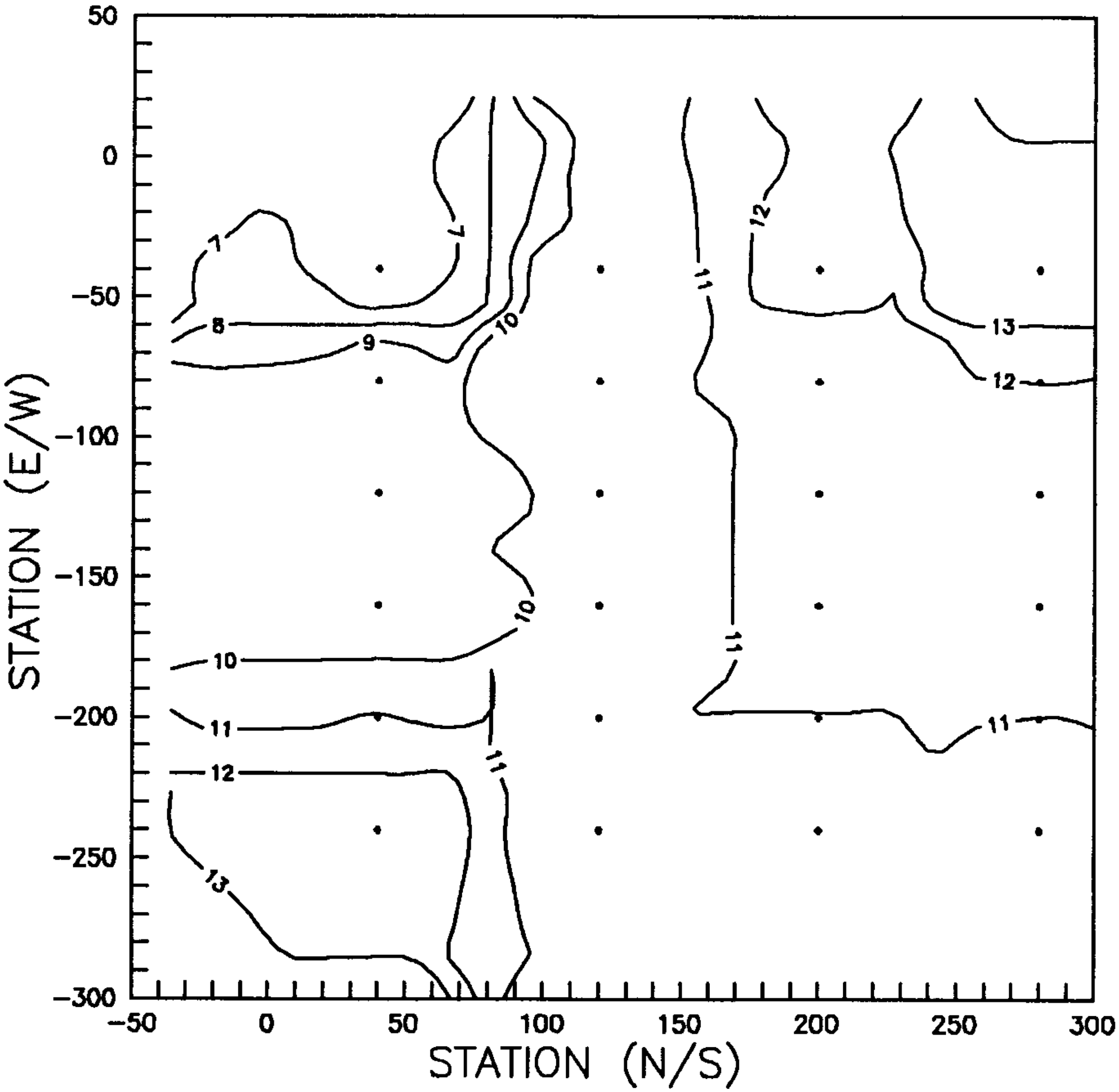
FIGURE **A-8**

GROUND CONDUCTIVITY MAP-
EM-34/20M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23503 DATE 1/8/91 DRAWN HP

Golder Associates



Explanation

• Data Point

Contour Interval = 1 mmho/m

Horizontal Dipole

Coils Oriented = North-South

N

FIGURE **A-9**

GROUND CONDUCTIVITY MAP- EM-34/40M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23504 DATE 1/8/91 DRAWN HP

Golder Associates

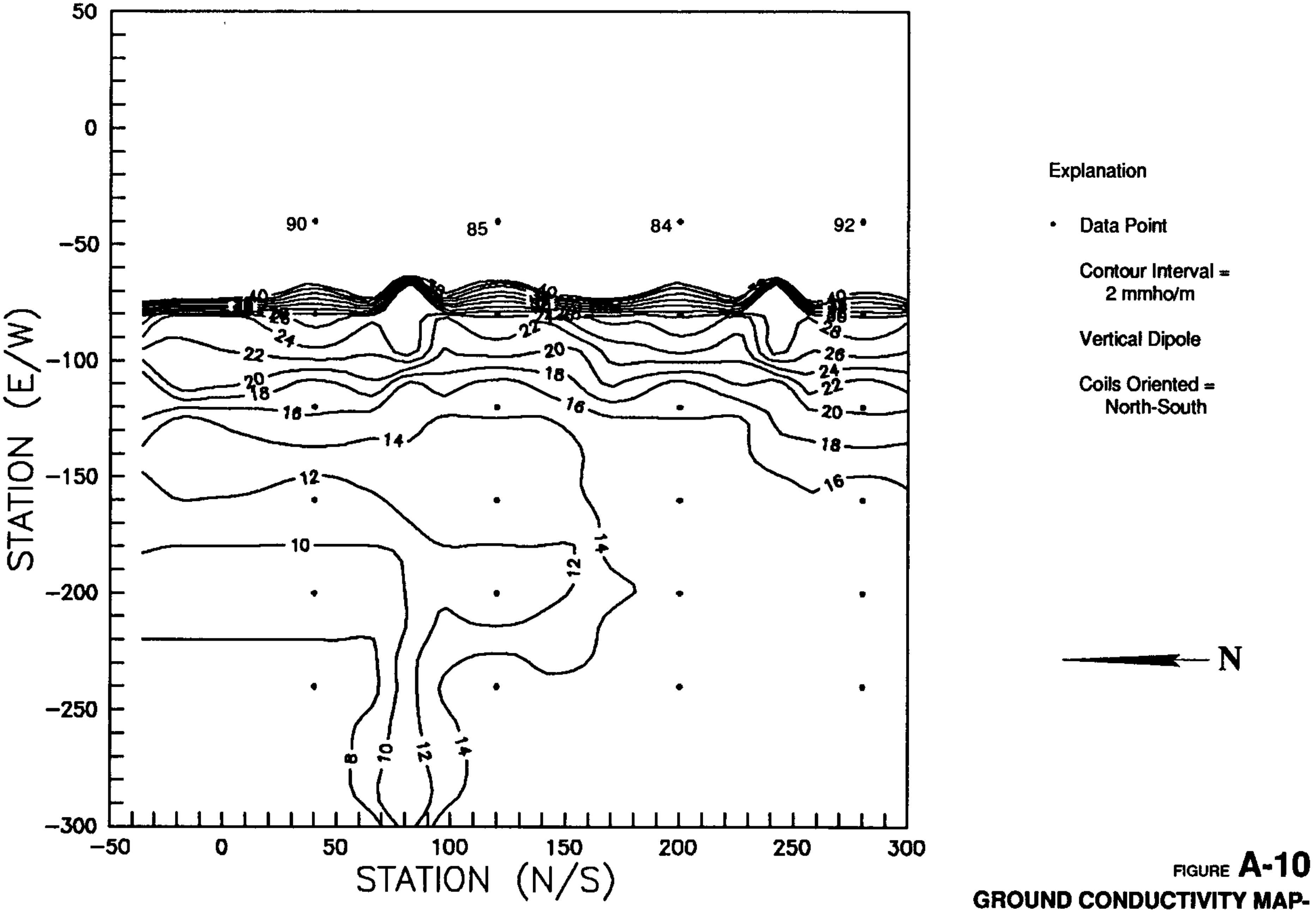


FIGURE **A-10**

GROUND CONDUCTIVITY MAP-
EM-34/40M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23506 DATE 1/8/91 DRAWN HP

Golder Associates

APPENDIX B

SELECTED GROUND PENETRATING RADAR PROFILES AT LDU CPP-37

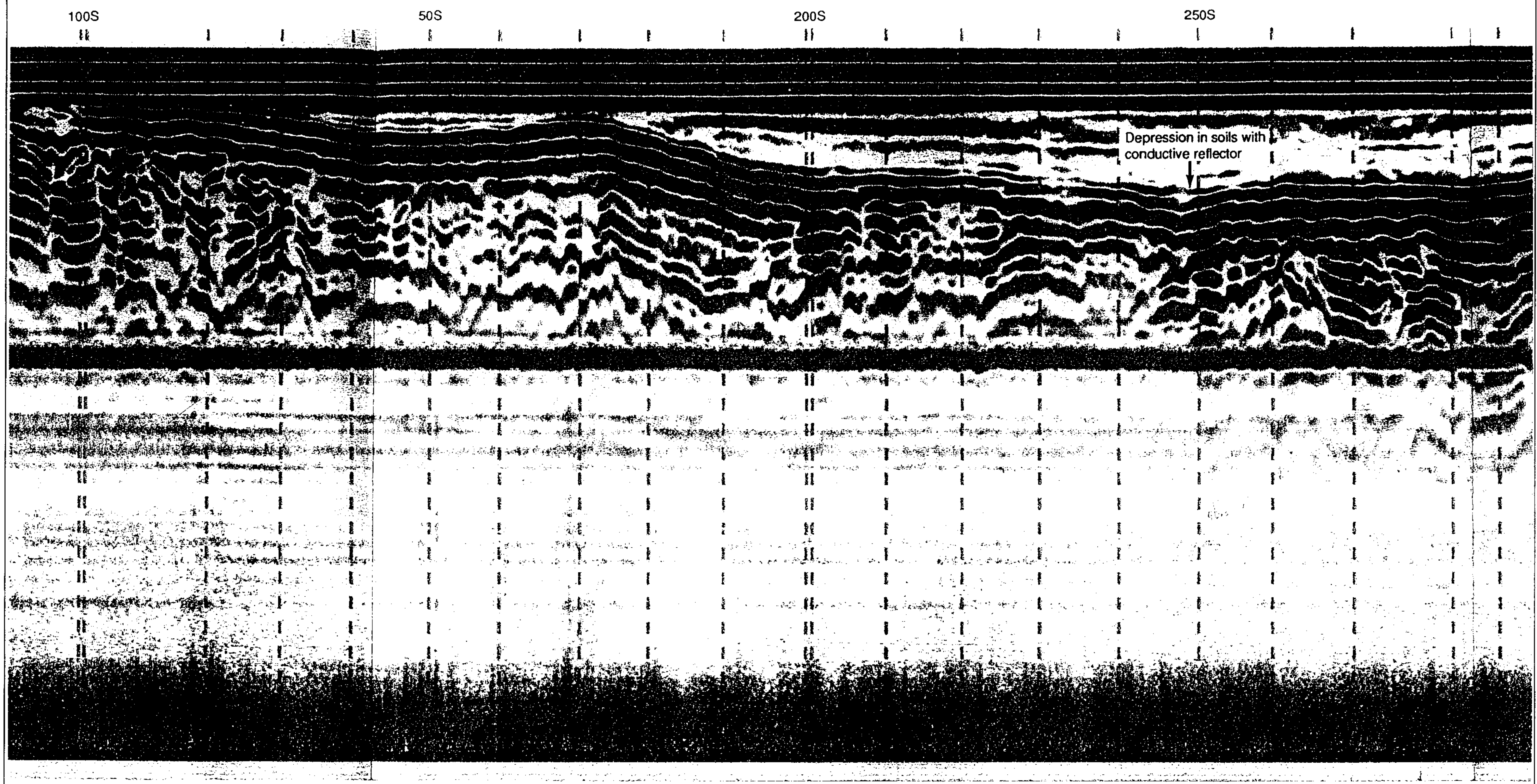


FIGURE **B-1**

GPR TRAVERSE ALONG LINE 40W - LDU CPP-37

EG&G/ICPP GEOPHYSICS

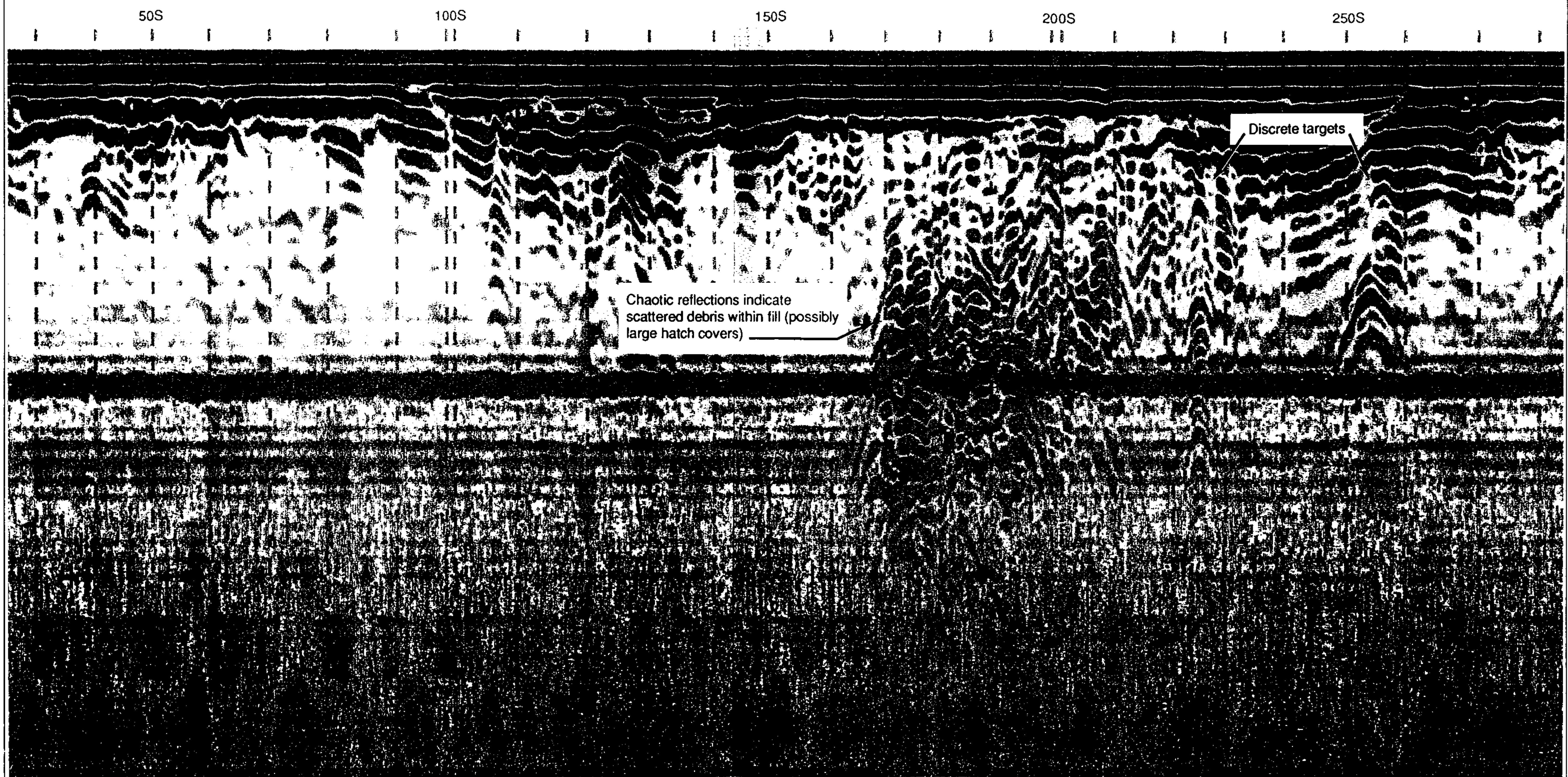


FIGURE **B-2**

GPR TRAVERSE ALONG LINE 240W - LDU CPP-37

EG&G/ICPP GEOPHYSICS

PROJECT NO. 893-1195.950 DWG NO. 23518 DATE 1/12/91 DRAWN HEP

Golder Associates

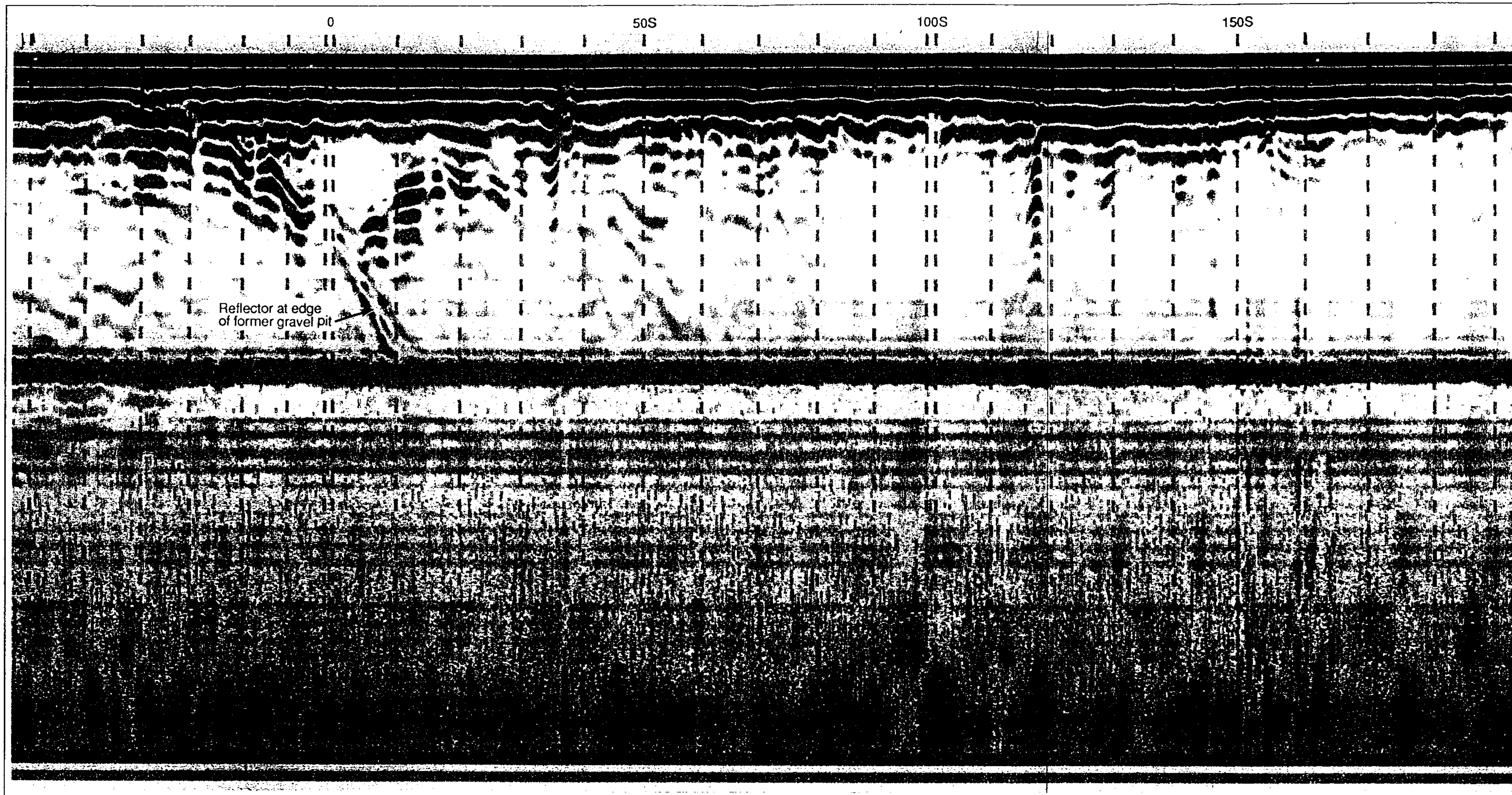


FIGURE **B-3**

GPR TRAVERSE ALONG LINE 140W - LDU CPP-37

EG&G/ICPP GEOPHYSICS

893-1195.950 23517 1/12/91 HEP

Golder Associates

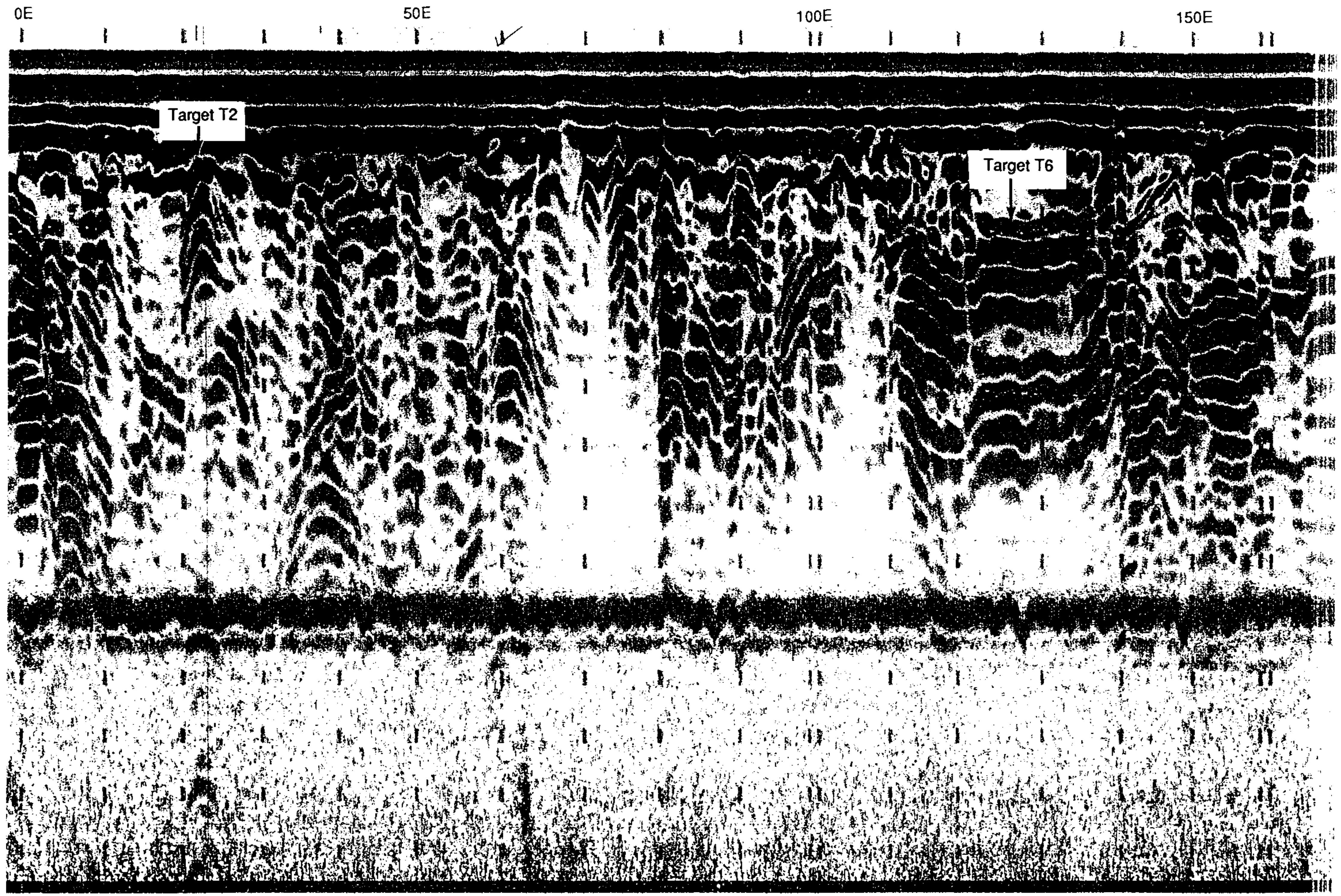


FIGURE **B-4**

GPR TRAVERSE ALONG LINE 90N - SWMU CPP-14

EG&G/ICPP GEOPHYSICS

PROJECT NO 893-1195.950 DWG NO 23516 DATE 1/12/91 DRAWN HEP

Golder Associates

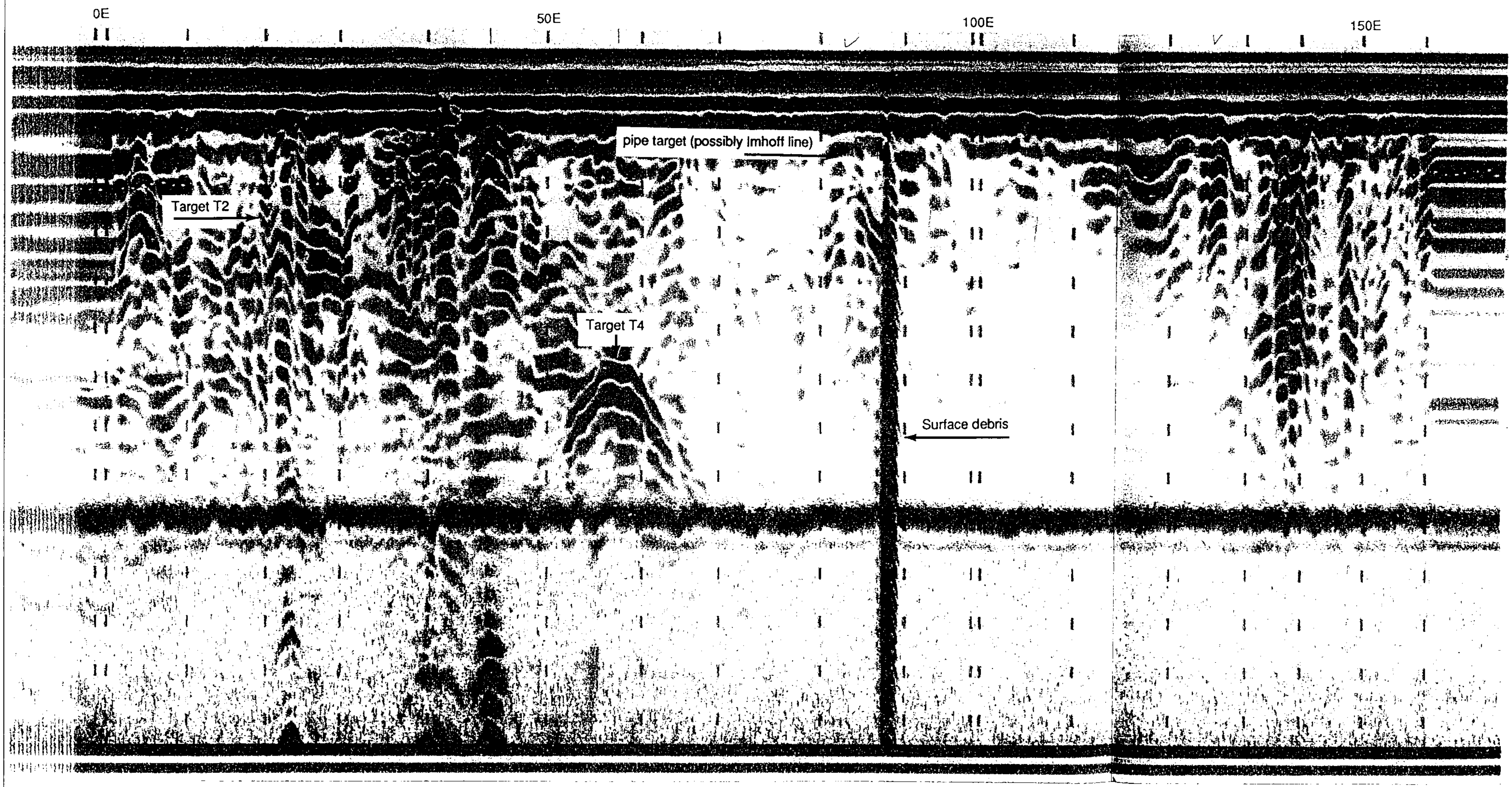


FIGURE **B-5**

GPR TRAVERSE ALONG LINE 60N - SWMU CPP-14

EG&G/ICPP GEOPHYSICS

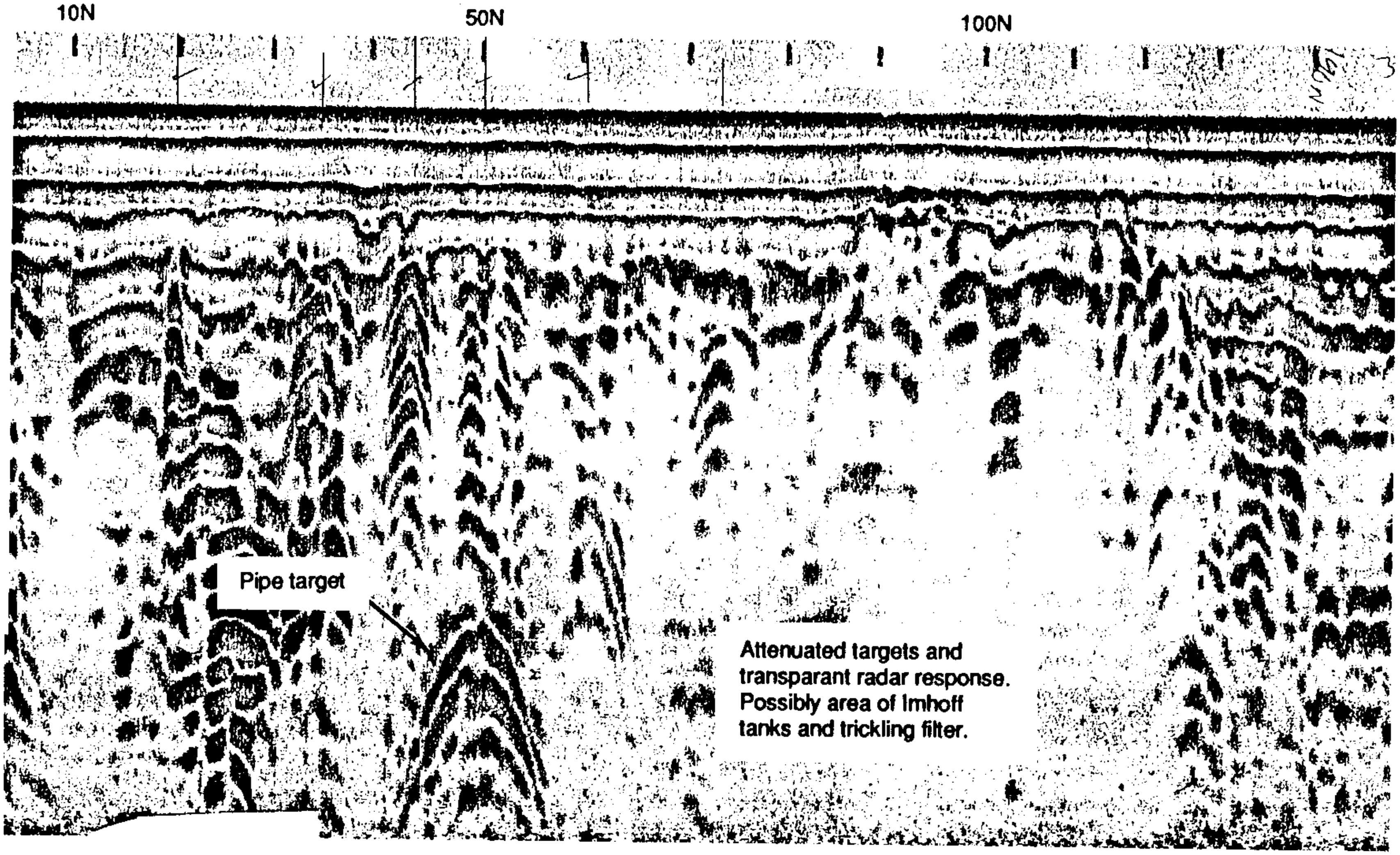


FIGURE **B-6**

GPR TRAVERSE ALONG LINE 70E - SWMU CPP-14

EG&G/ICPP GEOPHYSICS

PROJECT NO 893-1196.960 DWG NO 23622 DATE 1/12/91 DRAWN HEP

Golder Associates

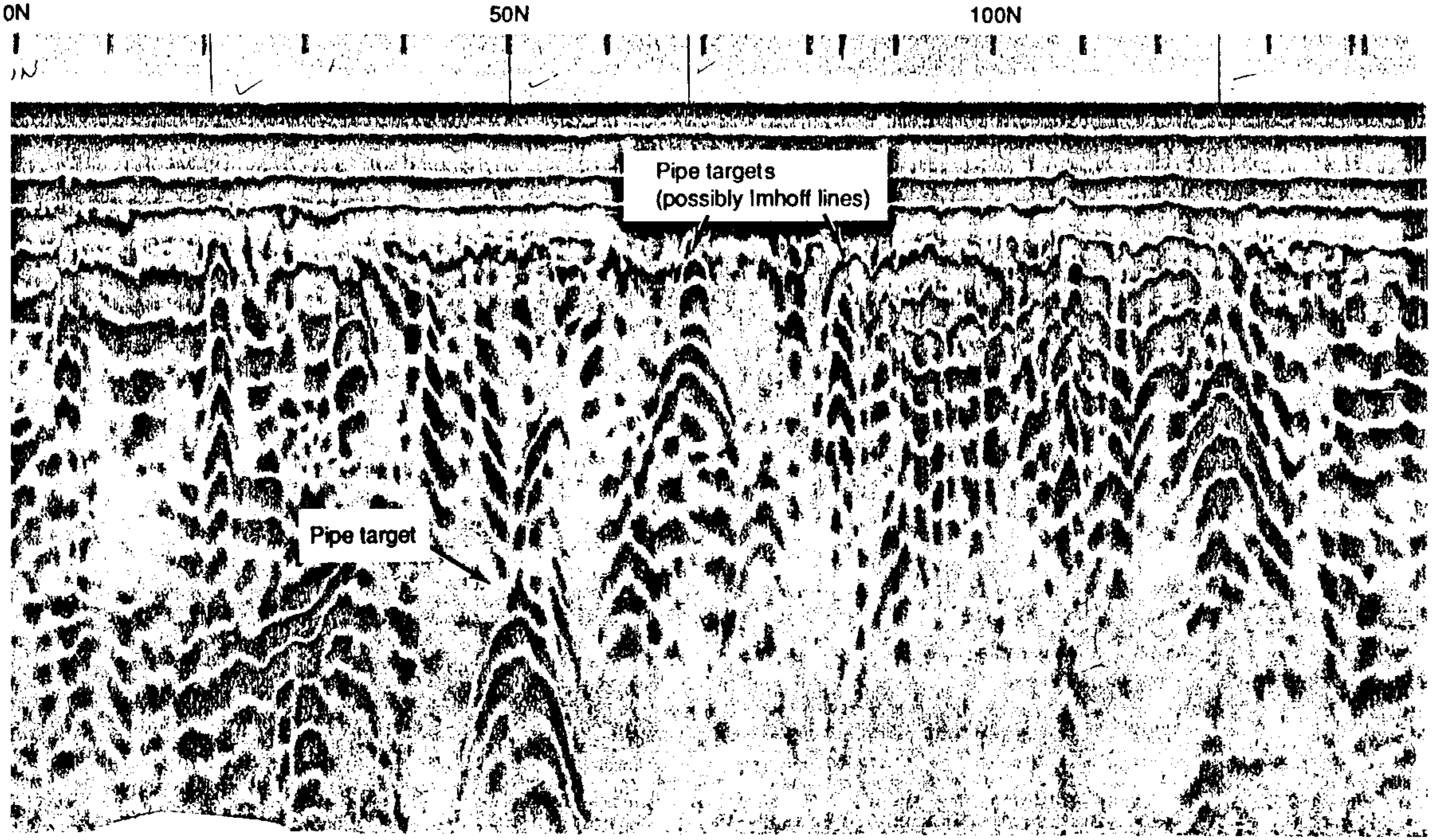


FIGURE **B-7**

GPR TRAVERSE ALONG LINE 80E-
SWMU CPP-14

EG&G/ICPP GEOPHYSICS

PROJECT NO 893-1196.960 DWG NO 23521 DATE 1/12/91 DRAWN HEP

Golder Associates

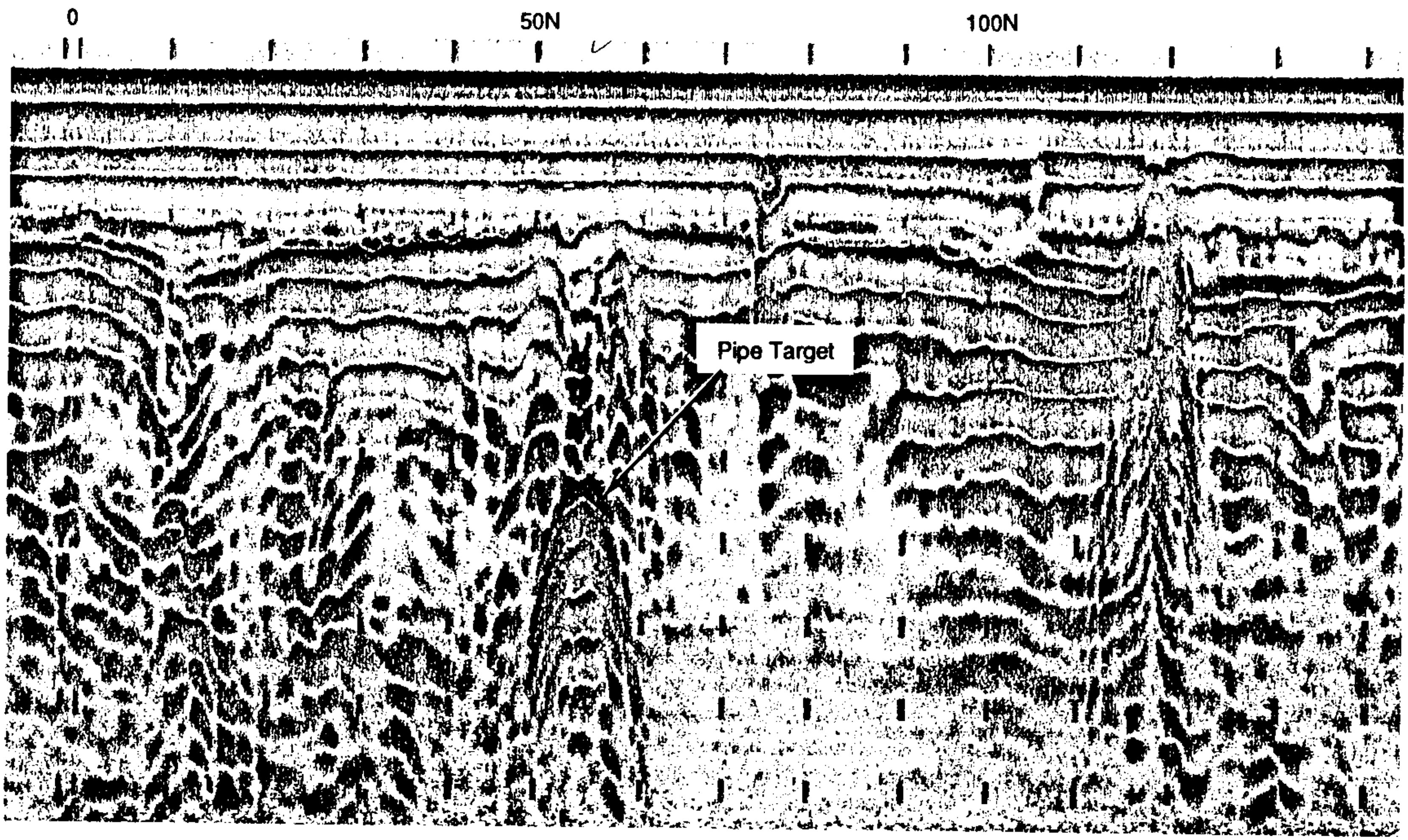


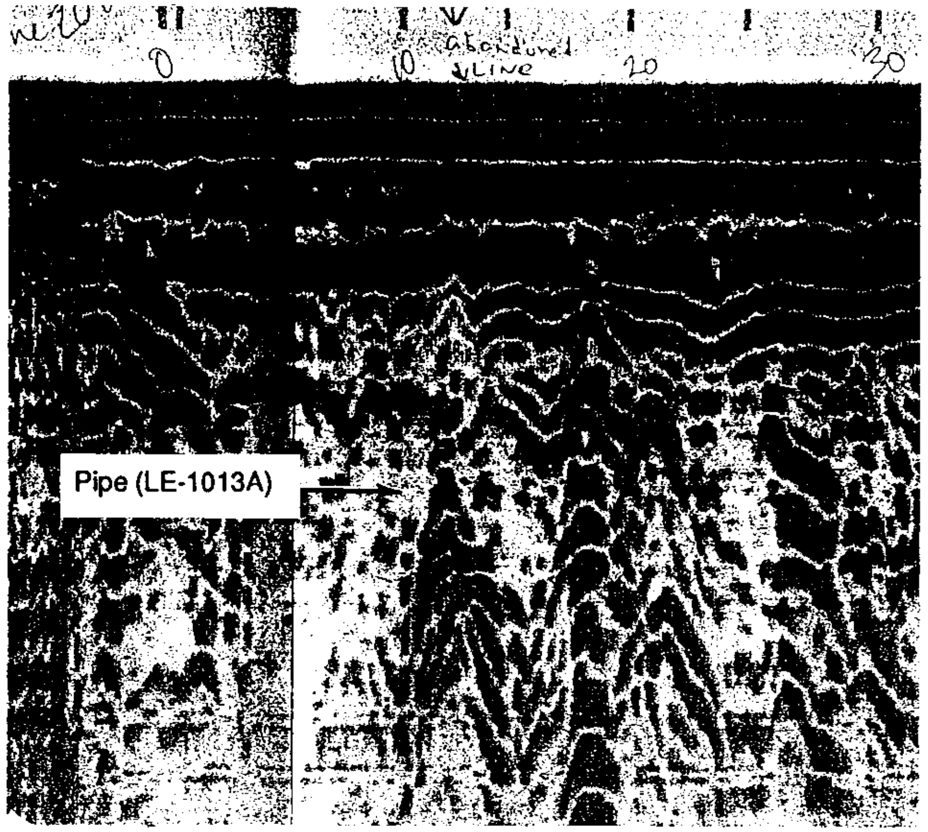
FIGURE **B-8**

GPR TRAVERSE ALONG LINE 210E - SWMU CPP-14

EG&G/ICPP GEOPHYSICS

PROJECT NO 893-1196.950 DWG NO 23620 DATE 1/12/91 DRAWN HEP

Golder Associates



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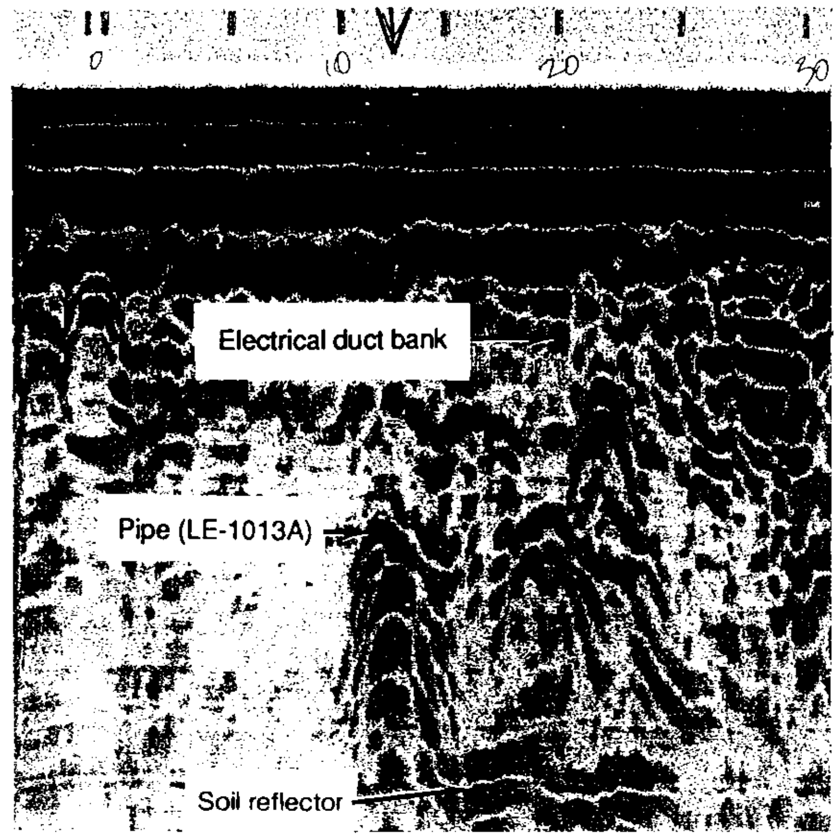

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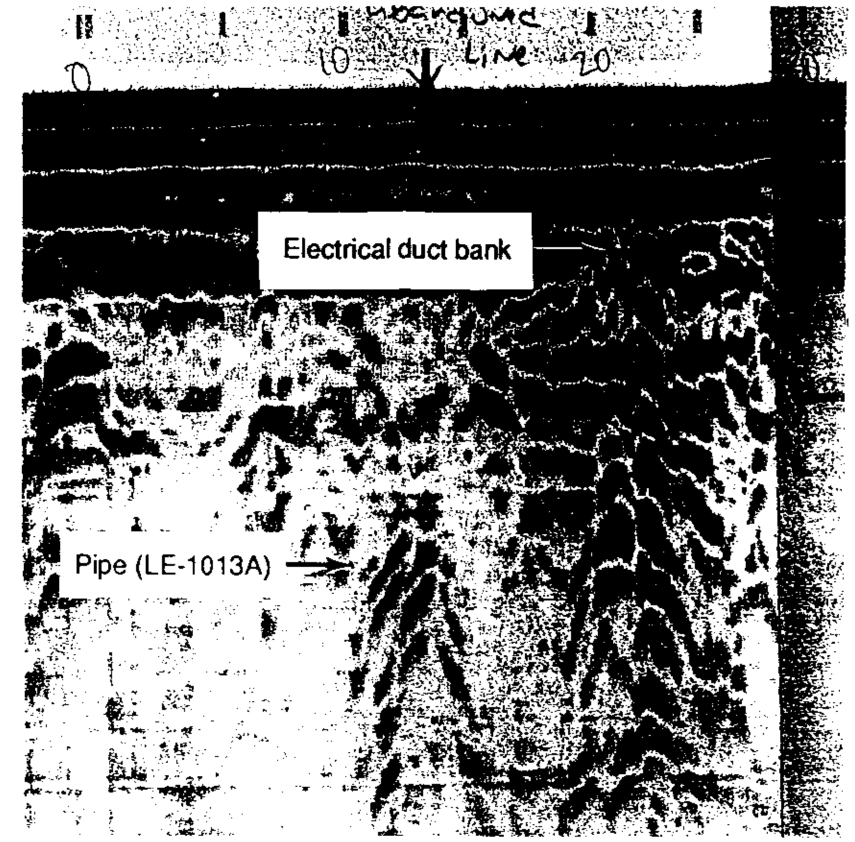
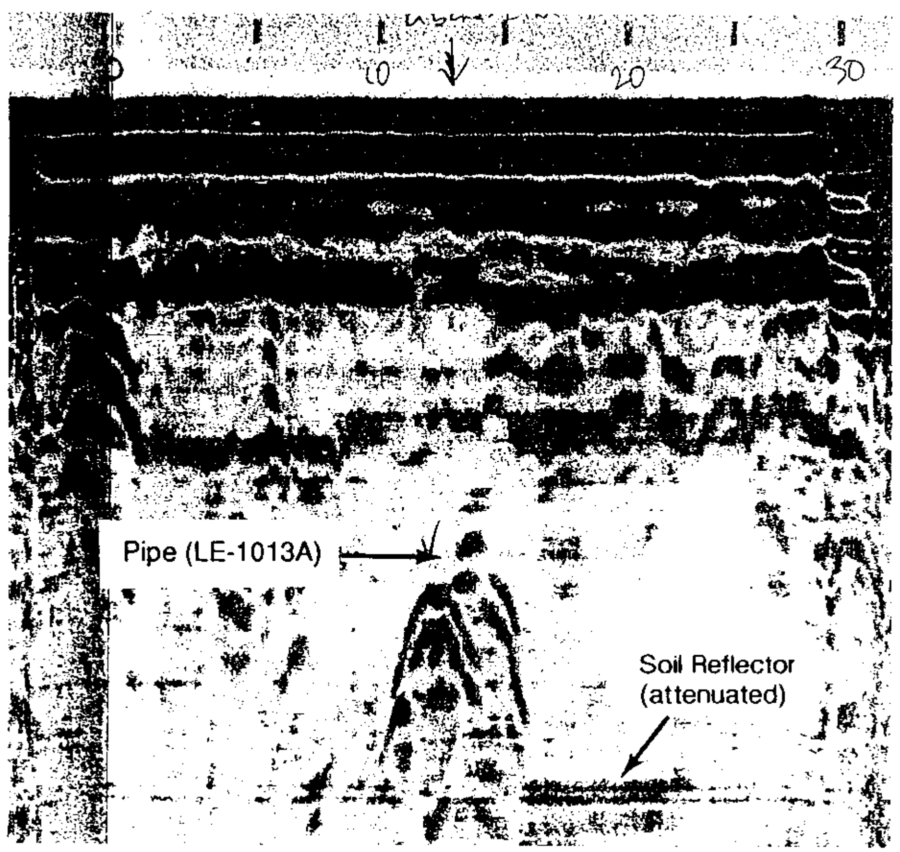
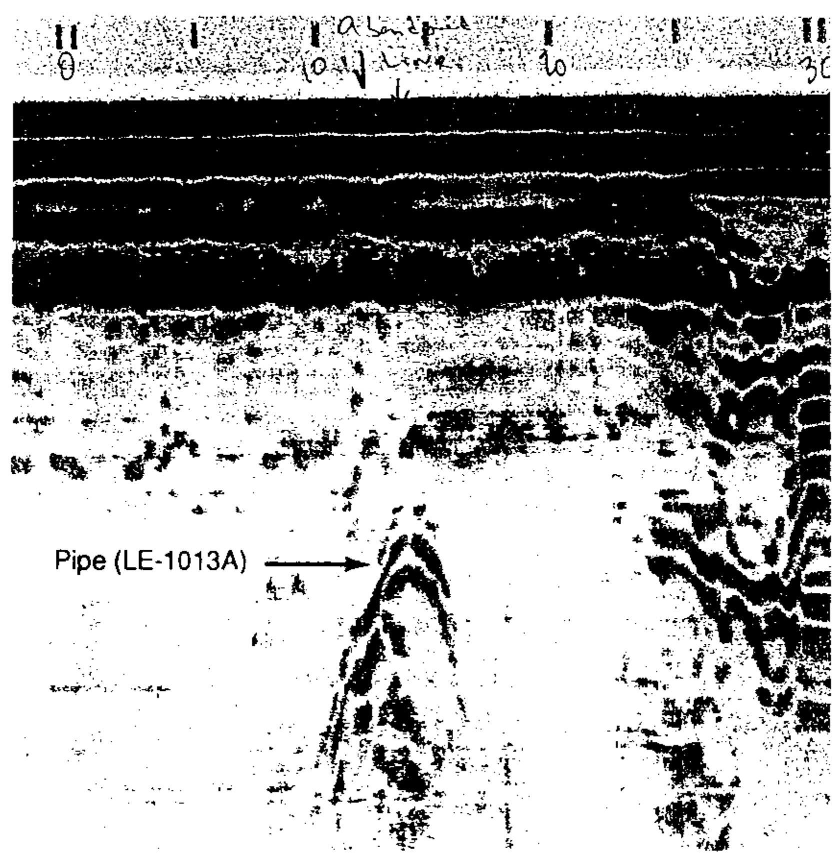


30



35 Soils around pipe become transparant



40 Soils around pipe are very transparant

Note: Break in pipe reportedly between lines 25 and 30

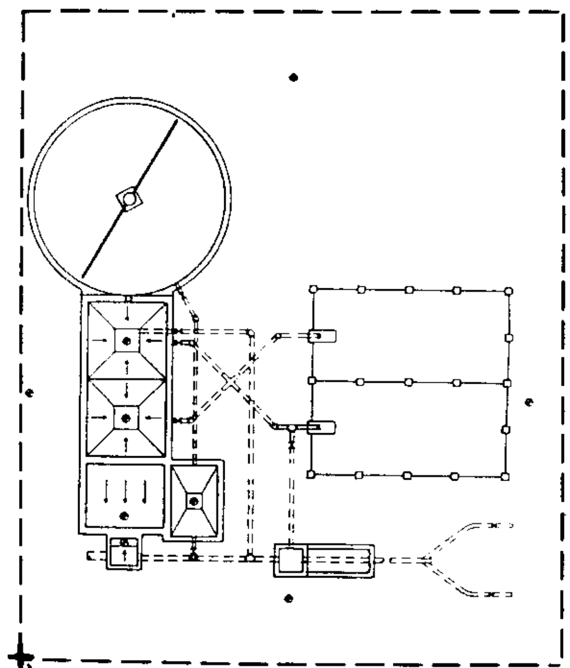
FIGURE **B-9**

ATTENUATION OF RADAR SIGNAL AT LDU CPP-63

EG&G/ICPP GEOPHYSICS

APPENDIX C

TRANSPARENT OVERLAYS OF EM CONTOUR PLOTS AND WASTE TREATMENT FACILITY AT SWMU CPP-14



Match Point to Figure 7

FIGURE **C-1**

TRANSPARANT OVERLAY OF FORMER SEWAGE TREATMENT FACILITY

EG&G/ICPP GEOPHYSICS

PROJECT NO. 893-1195.950 DWG. NO. 23595a DATE 1/00/89 DRAWN CW

Golder Associates

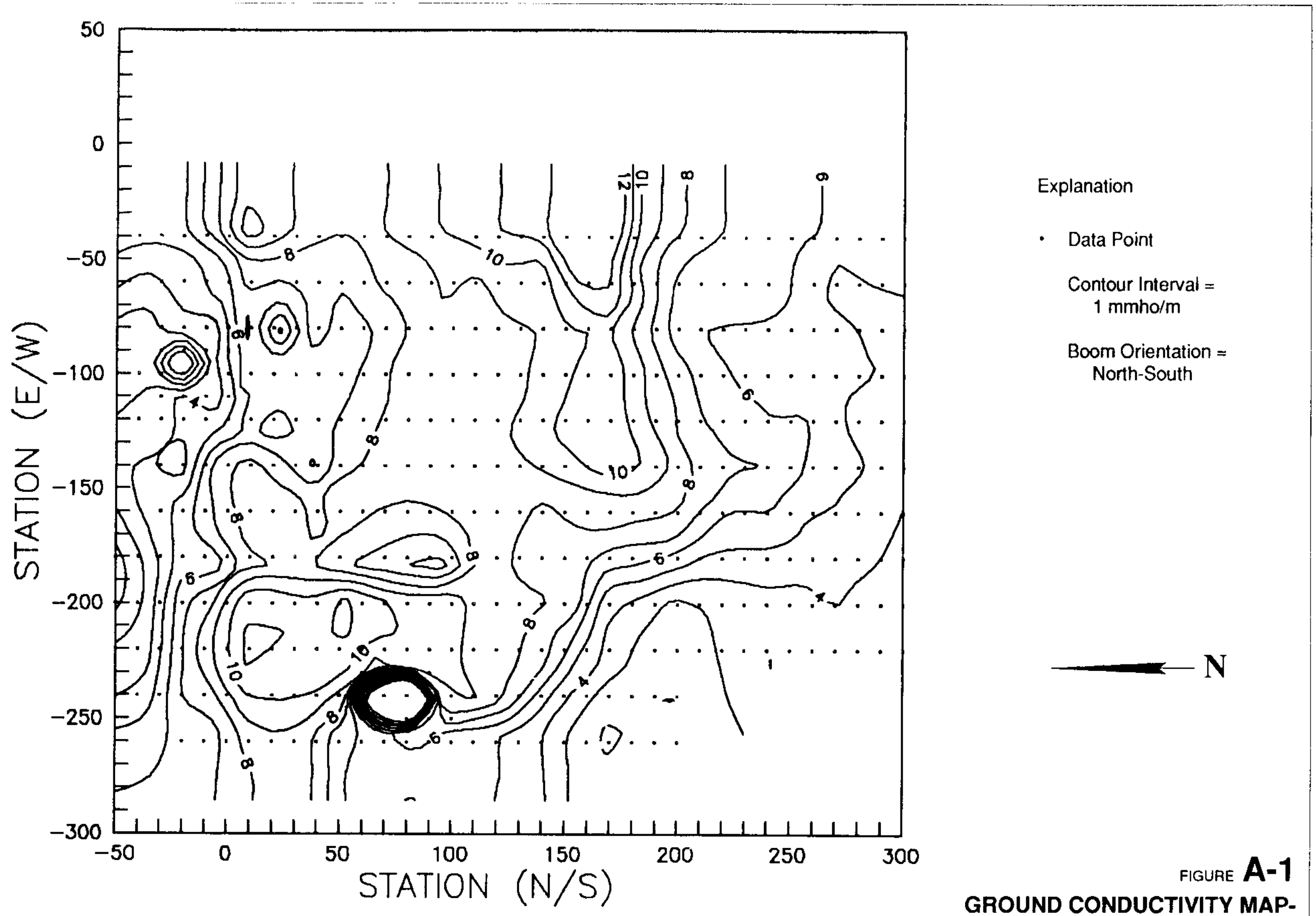


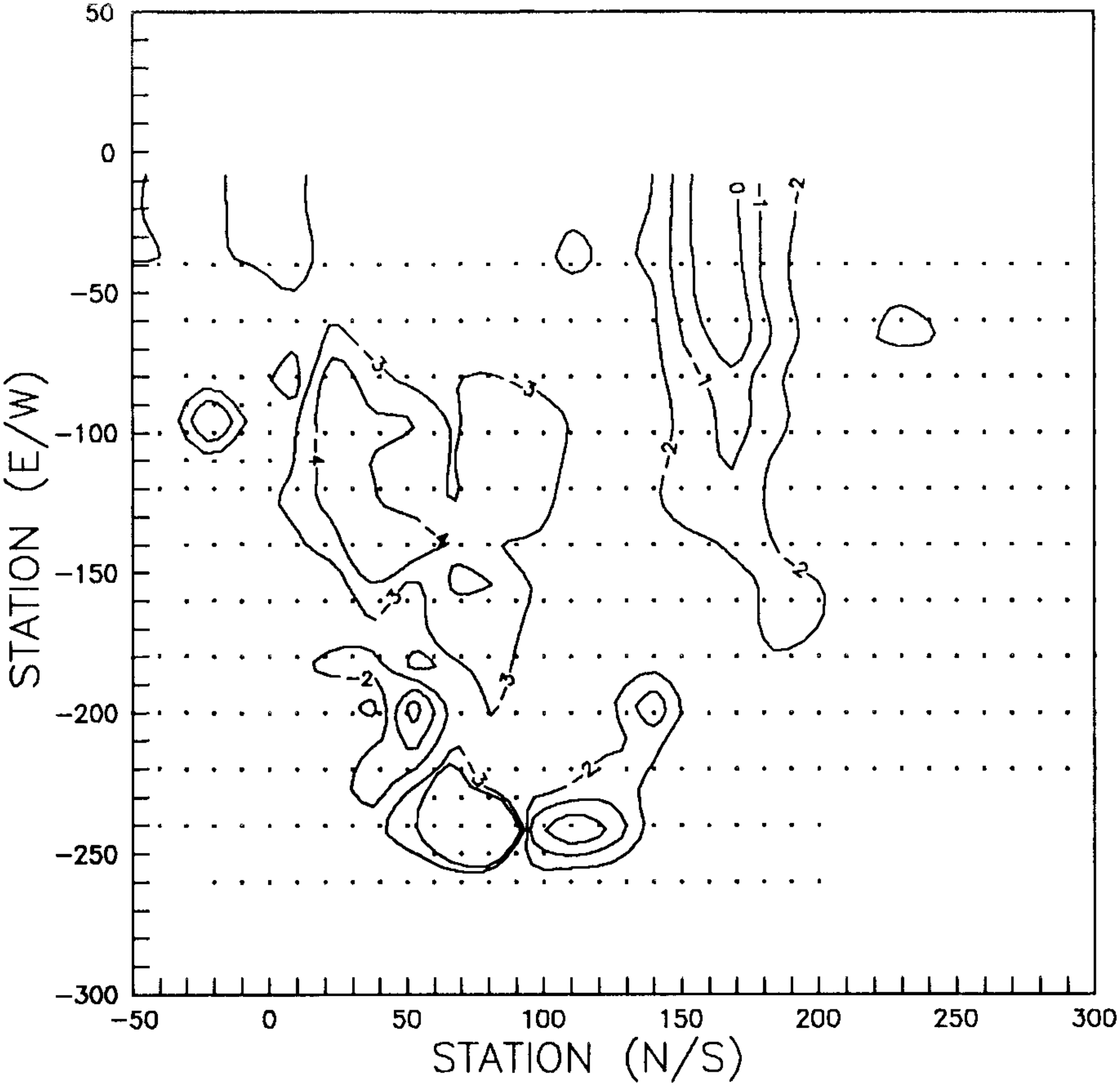
FIGURE **A-1**

GROUND CONDUCTIVITY MAP-
EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23496 DATE 1/8/91 DRAWN HP

Golder Associates



Explanation

• Data Point

Contour Interval = 1 ppt.

Boom Orientation = North-South

FIGURE **A-2**

IN-PHASE COMPONENT MAP-EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23497 DATE 1/8/91 DRAWN HP

Golder Associates

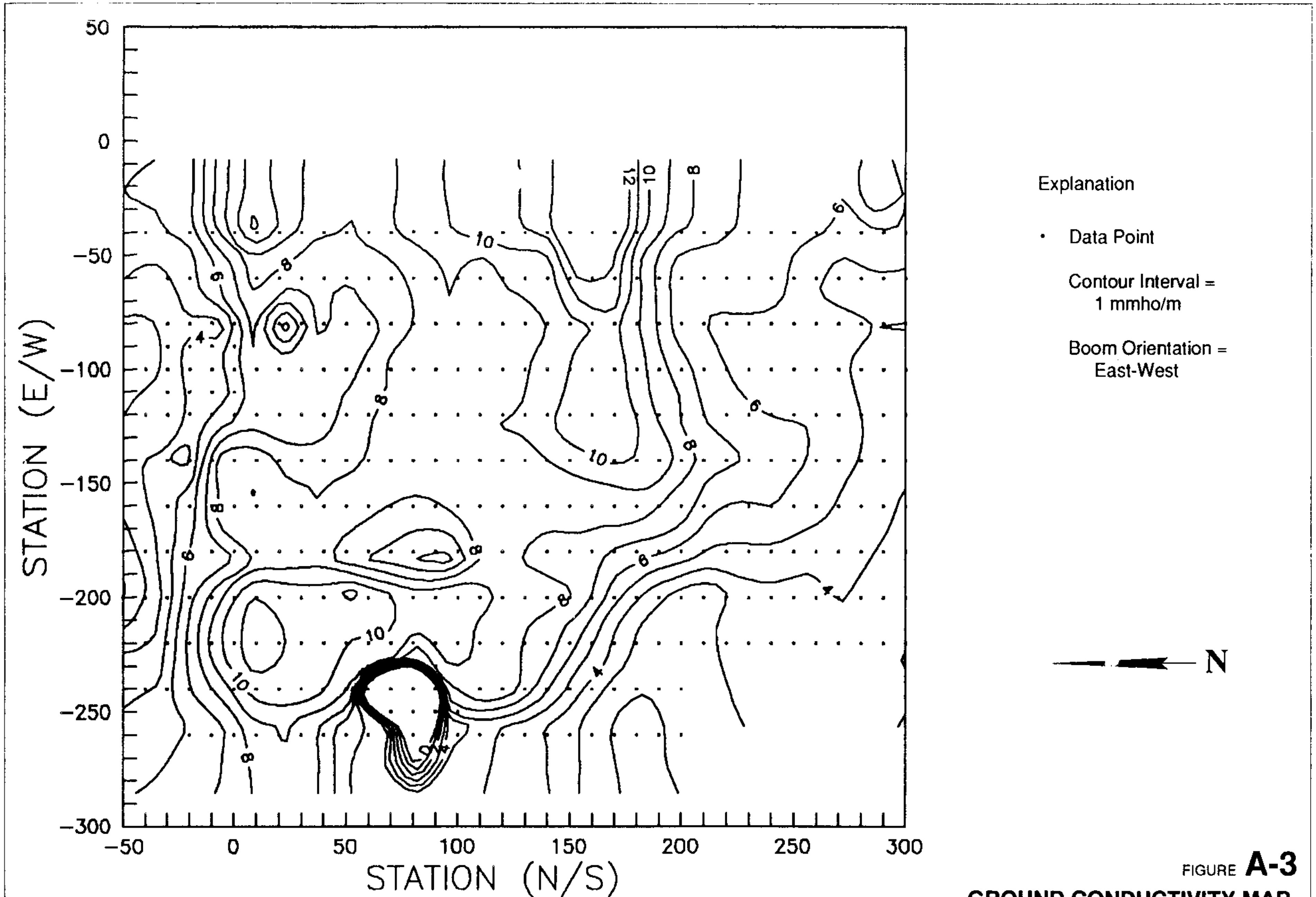


FIGURE **A-3**

GROUND CONDUCTIVITY MAP-EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23498 DATE 1/8/91 DRAWN HP

Golder Associates

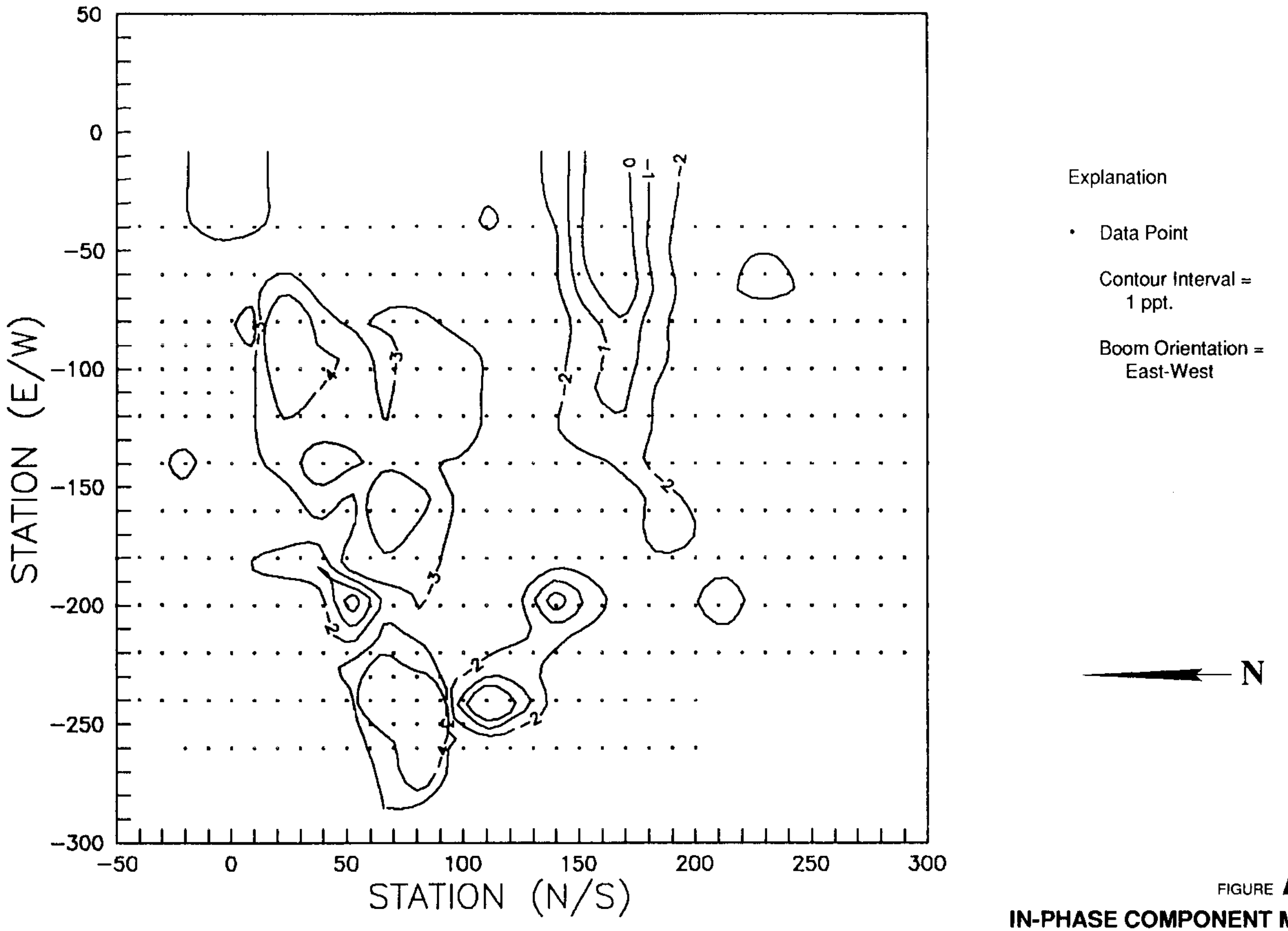


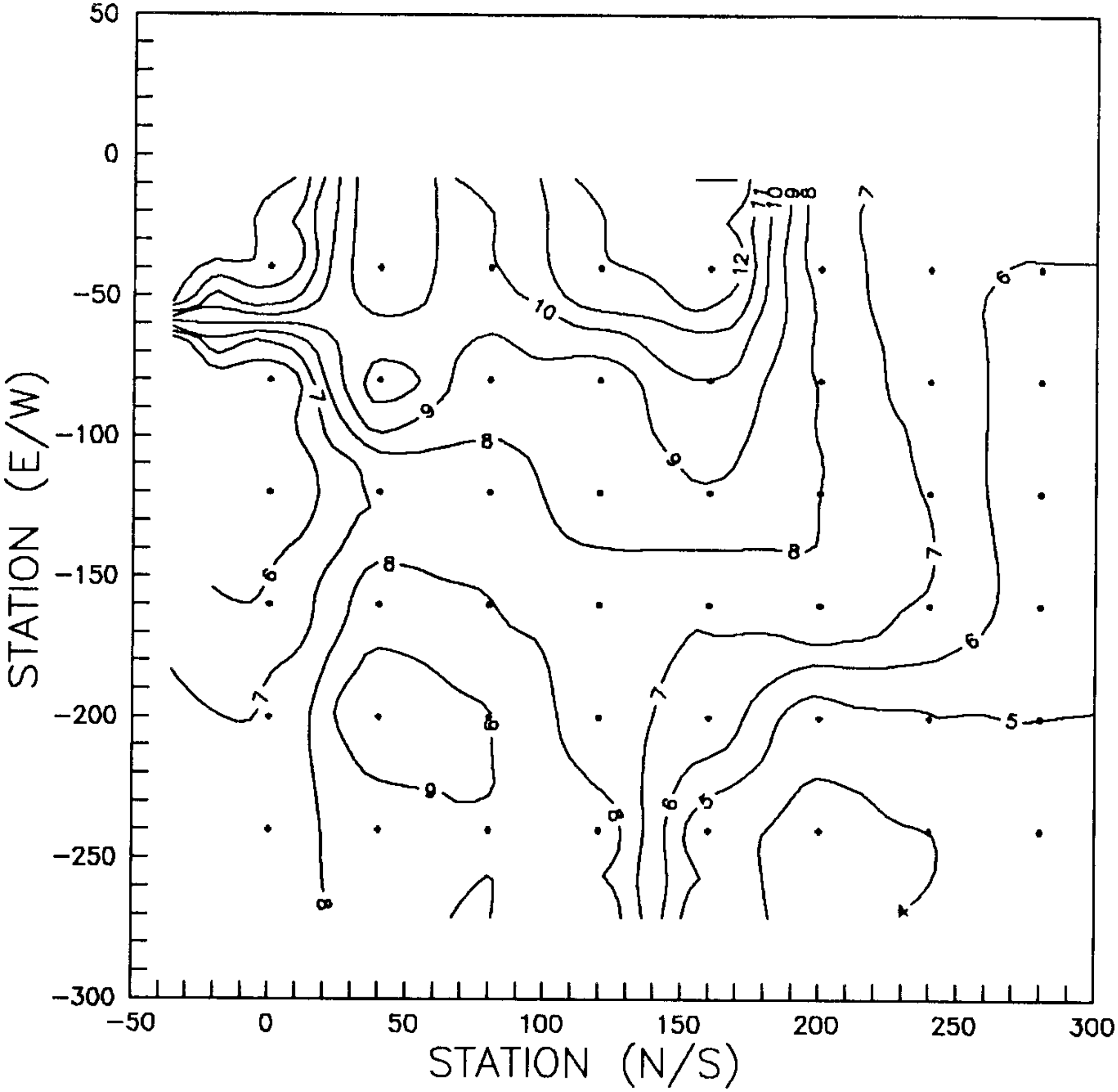
FIGURE **A-4**

IN-PHASE COMPONENT MAP-
EM-31 AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23499 DATE 1/8/91 DRAWN HP

Golder Associates



Explanation

• Data Point

Contour Interval = 1 mmho/m

Horizontal Dipole

Coils Oriented = North-South

FIGURE **A-5**

GROUND CONDUCTIVITY MAP-EM-34/10M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23500 DATE 1/8/91 DRAWN HP

Golder Associates

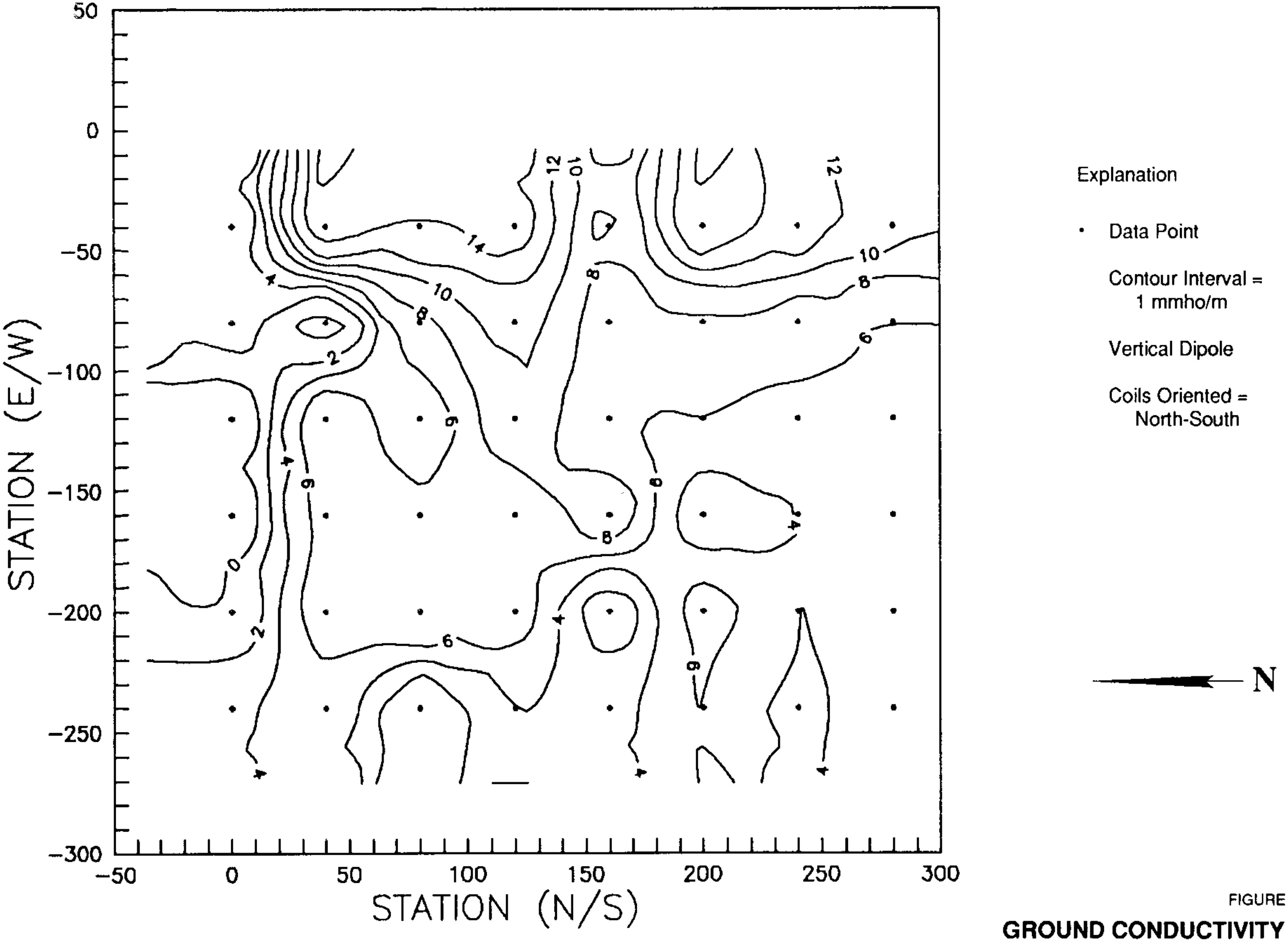


FIGURE **A-6**

GROUND CONDUCTIVITY MAP-
EM-34/10M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23501 DATE 1/8/91 DRAWN HP

Golder Associates

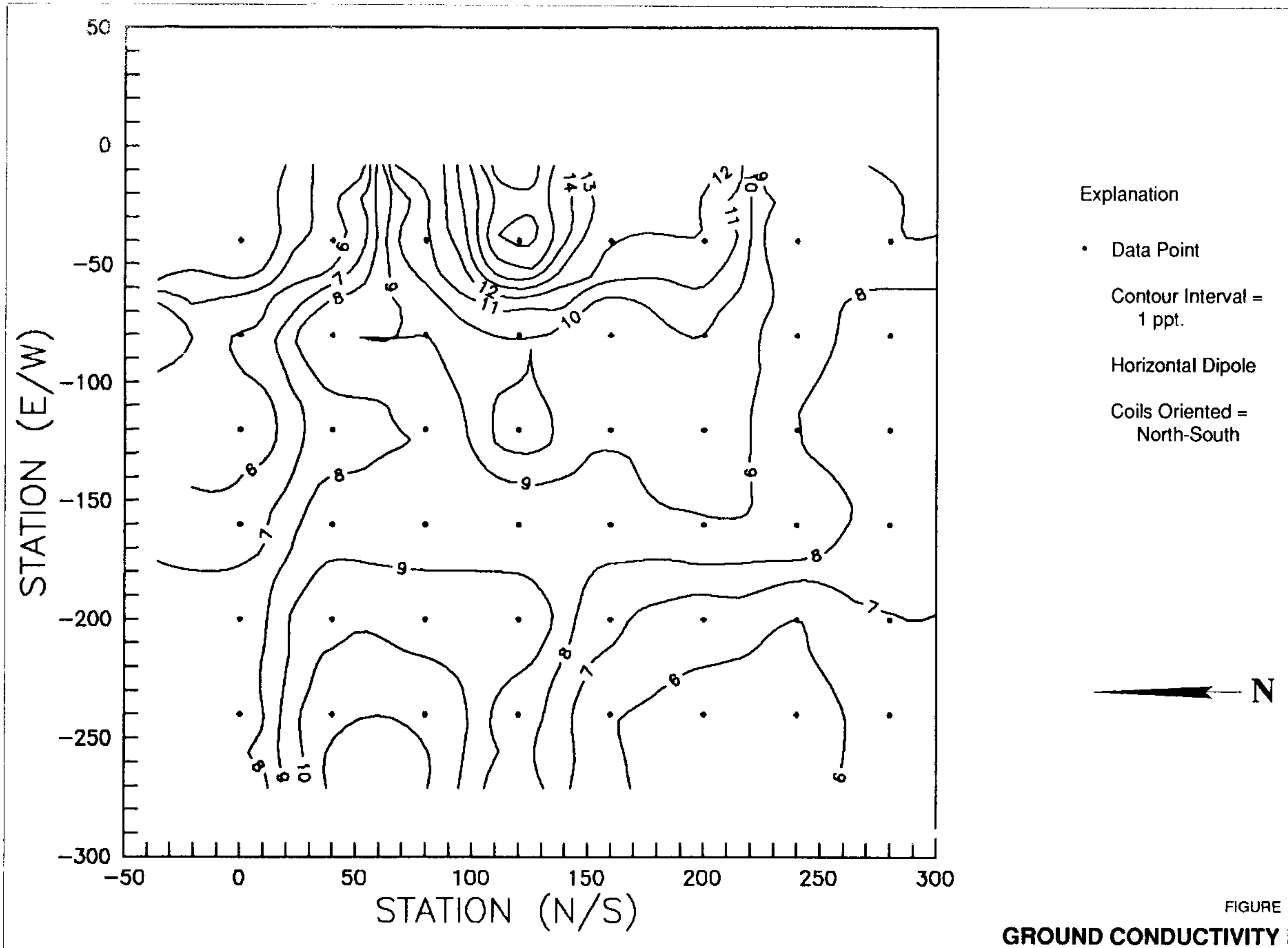


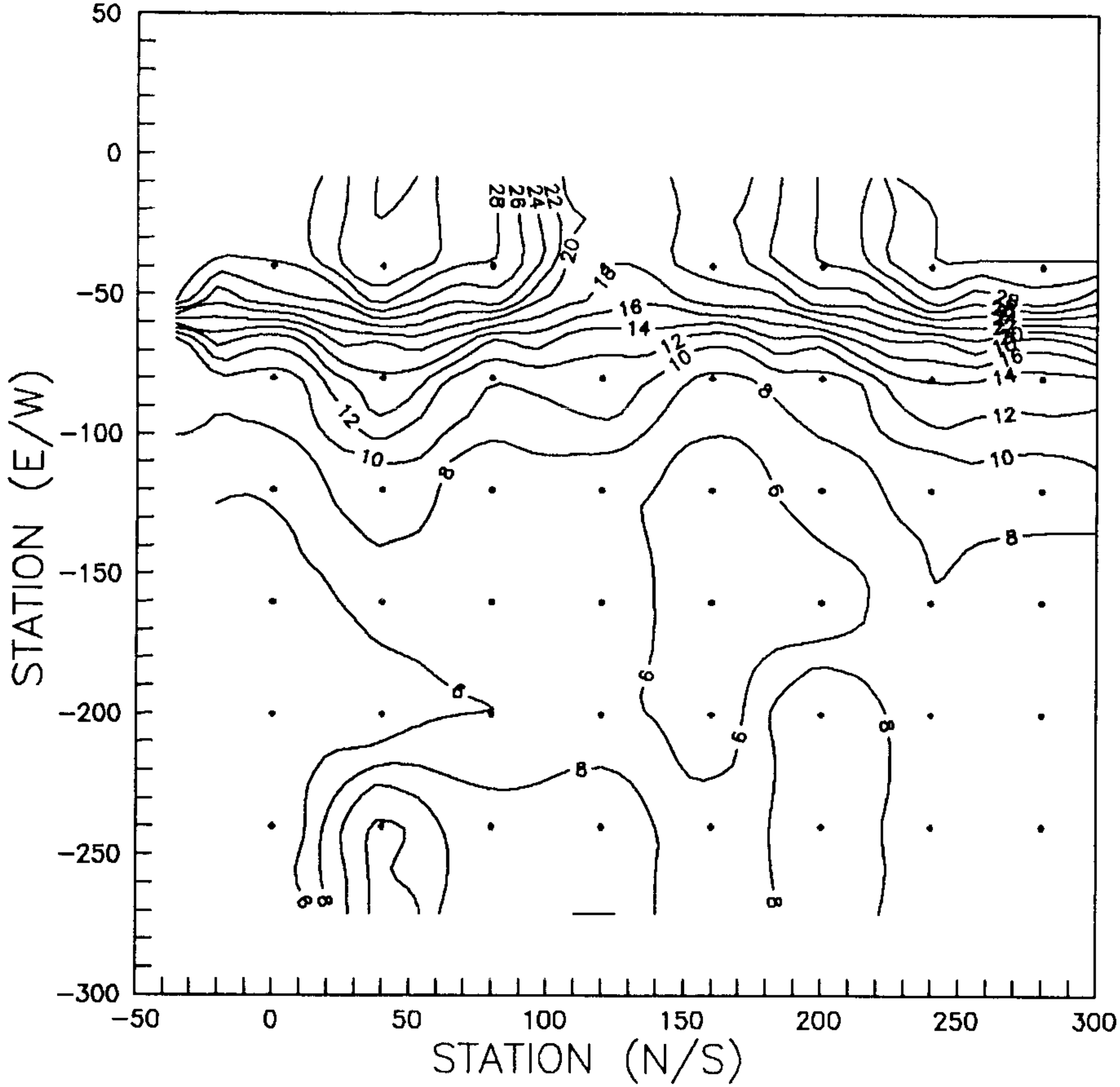
FIGURE **A-7**

GROUND CONDUCTIVITY MAP-EM-34/20M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23502 DATE 1/8/91 DRAWN HP

Golder Associates



Explanation

• Data Point

Contour Interval = 2 mmho/m

Vertical Dipole

Coils Oriented = North-South

N

FIGURE **A-8**

GROUND CONDUCTIVITY MAP-
EM-34/20M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23503 DATE 1/8/91 DRAWN HP

Golder Associates

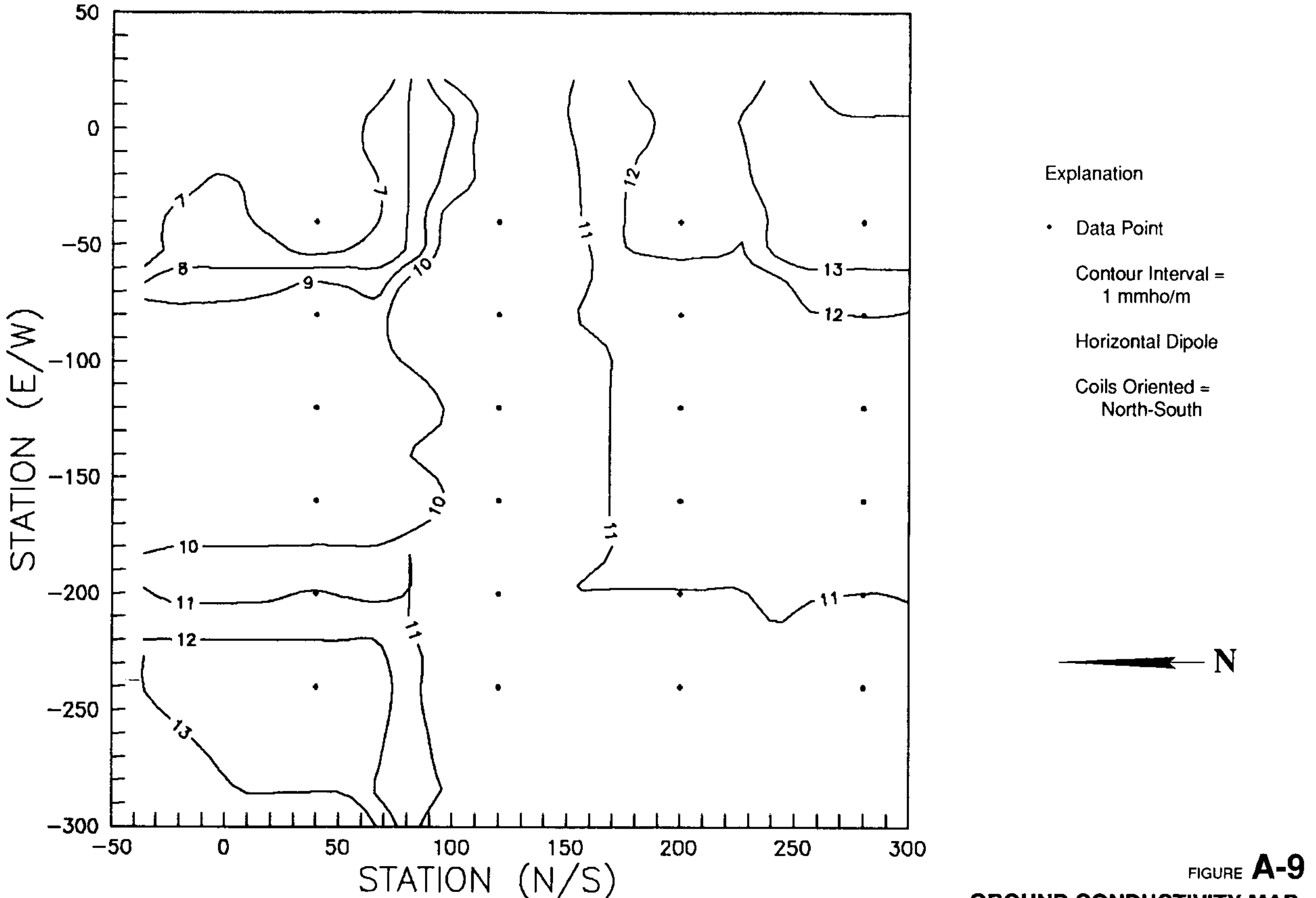


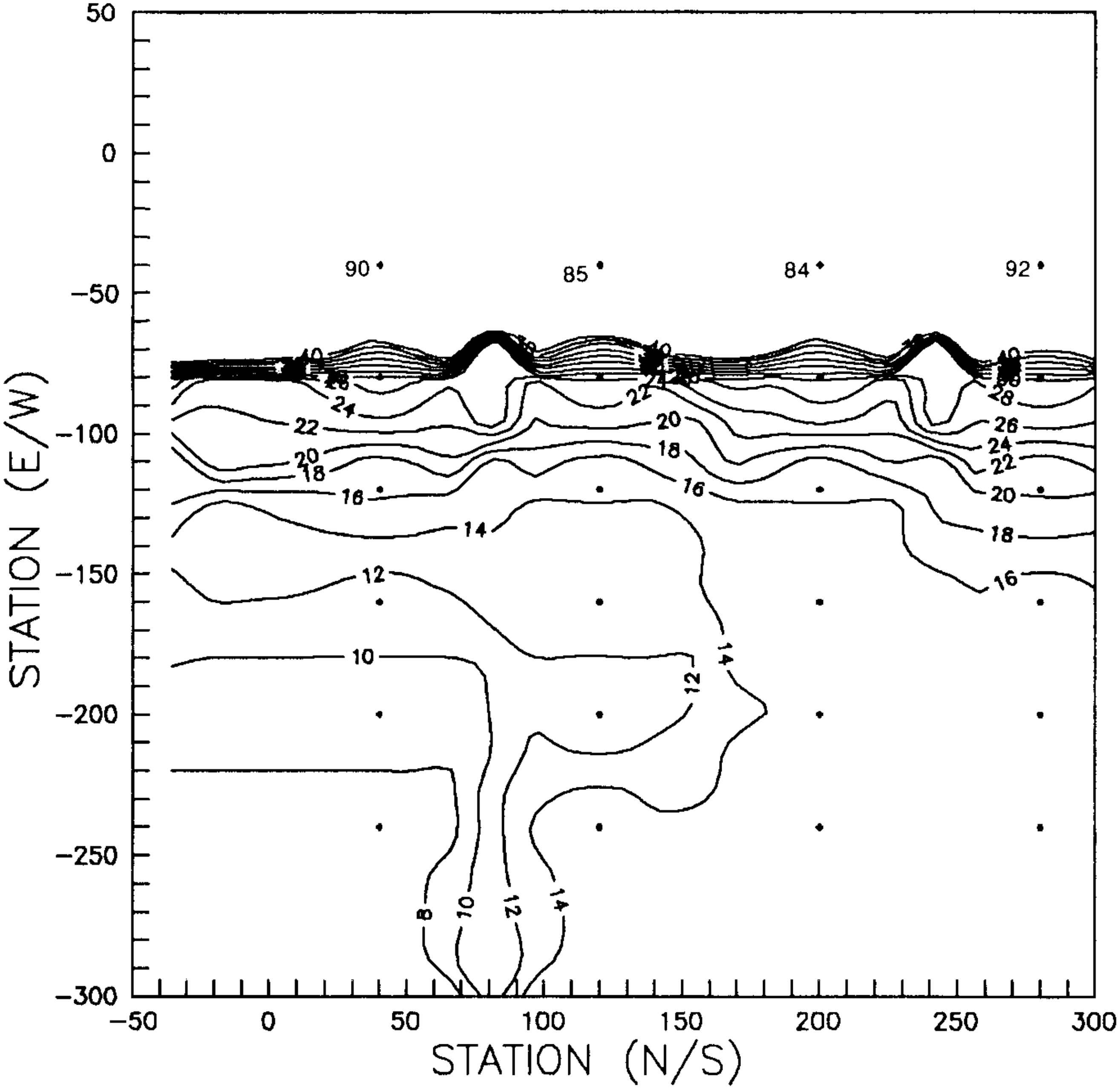
FIGURE **A-9**

GROUND CONDUCTIVITY MAP-EM-34/40M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23504 DATE 1/8/91 DRAWN HP

Golder Associates



Explanation

• Data Point

Contour Interval = 2 mmho/m

Vertical Dipole

Coils Oriented = North-South

N

FIGURE **A-10**

GROUND CONDUCTIVITY MAP-
EM-34/40M COIL AT LDU CPP-37

EG&G/GEOPHYSICS REPORT

PROJECT NO. 893-1195.950 DWG. NO. 23505 DATE 1/8/91 DRAWN HP

Golder Associates